PRESENT AND POTENTIAL IMPACT OF ORGANIC CHEMICAL CONTAMINATION ON THE JAMAICA WATER SUPPLY COMPANY SYSTEM, QUEENS AND NASSAU, NEW YORK

Prepared For

JAMAICA WATER SUPPLY COMPANY

May 1983

By

Leggette, Brashears & Graham, Inc.

and

A. Guerrera Associates

PRESENT AND POTENTIAL IMPACT OF ORGANIC CHEMICAL CONTAMINATION ON THE JAMAICA WATER SUPPLY COMPANY SYSTEM QUEENS AND NASSAU, NEW YORK

Prepared For

Jamaica Water Supply Company

May 1983

LEGGETTE, BRASHEARS & GRAHAM, INC.
Consulting Ground-Water Geologists
Wilton, Connecticut

and

A. GUERRERA ASSOCIATES
Consulting Chemists
Hauppauge, New York

LEGGETTE, BRASHEARS & GRAHAM, INC.

CONSULTING GROUND-WATER GEOLOGISTS

EDWARD T. SIMMONS
G. SIDNEY FOX
FRANK H. CRUM
R. G. SLAYBACK
MICHAEL R. BURKE
HARRY F. OLESON
ROBERT LAMONICA

WILTON
72 DANBURY ROAD
WILTON, CT. 06897
(203) 762-1207
CABLE ADDRESS - LEBRAGRA

TAMPA
1211 N. WESTSHORE BLVD.
TAMPA, FL. 33607
(813) 879-8177
CABLE ADDRESS - AGUAFLA

WATER SUPPLY
DEWATERING
RECHARGING
SALT WATER PROBLEMS
POLLUTION STUDIES
REPORTS

PLEASE ADDRESS REPLY TO
WILTON, CONNECTICUT

May 19, 1983

Mr. Andrew T. Dwyer, President
Jamaica Water Supply Company
410 Lakeville Road
Lake Success, NY 11042

Dear Mr. Dwyer:

Herewith is our report, "Present and Potential Impact of Organic Chemical Contamination on the Jamaica Water Supply Company System, Queens and Nassau, New York". This report was prepared jointly by our firm and A. Guerrera Associates, as authorized on March 28, 1983.

Mr. Guerrera and I stand ready to discuss this report with the Water Company.

Thank you for this opportunity to have been of service.

Very truly yours,

LEGGETTE, BRASHEARS & GRAHAM, INC.

R. G. Slayback
Vice President

RGS:dm
Enclosures

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

PRESENT AND POTENTIAL IMPACT OF ORGANIC CHEMICAL CONTAMINATION ON THE JAMAICA WATER SUPPLY COMPANY SYSTEM QUEENS AND NASSAU, NEW YORK

SUMMARY

A 6-week review study of the Jamaica Water Supply Company well-water supply has been completed, primarily to assess the present loss of productive capacity due to organic chemical contamination and the vulnerability of the system to loss of other wells to this cause. At the time of reporting, 15 wells in Queens County and one well in Nassau County, having an aggregate yield capacity of 15.7 million gallons per day, exceed the New York State "actionable guidelines" for organic constituents. This does not necessarily mean that all of this capacity is lost for 1983, since concentrations in some wells might fall below the guidelines, and some wells appear to deliver acceptable quality water as the result of prevailing mixing patterns and aeration treatment for iron and carbon dioxide removal prior to delivery to the system.

In addition, the study has identified four wells in Queens and one well in Nassau, having a total rated capacity of 6.4 million gallons per day that are regarded as having a high risk of degradation of water quality by organic compounds to levels exceeding the potable water guidelines in the near future, and as early as within 1983. Any number of conditions might cause the water from these wells to remain within the "actionable guidelines" but prudent supply planning would assume that they may be closed in 1983.

Ten wells in Queens and nine wells in Nassau have been assessed as having a moderate risk of organic chemical degradation, due largely to the local land-use environment, the presence of low levels of organics and/or downward flow gradients. These wells involve 9.7 and 12.9 million gallons

per day of rated capacity in Queens and Nassau respectively. It is estimated that 20 to 30 percent of these wells might be lost to organic contamination in the next several years, but which wells among this group cannot be selected with any certainty.

In Nassau, in addition to the one well out of service and one well regarded as a high risk situation, there are a surprisingly high number of wells, nine with a rated capacity of 13 million gallons per day, perceived as having a moderate risk of degraded organic quality in the next several years.

The Water Company's plans to ameliorate the situation by installing treatment facilities at key well stations will begin to restore lost capacity as early as April 1984. A program of redrilling and deepening several wells in the 1983-1985 period is expected to further replace lost capacity. Specific recommendations regarding these plans are provided in this report. In the interim period, it appears critical that lost capacity, and capacity likely to be lost, in the amount of about 10 to 12 million gallons per day be replaced in the Queens system.

Two interconnections with the New York City system are understood to have the potential to add about 10 million gallons per day to the eastern Queens area. Use of this water in non-peak periods would allow problem wells in this area to be rested, so as to be able to meet peak-season demand before contamination levels exceed the State quality quidelines.

For the longer term, the technical, regulatory and economic feasibility of installing additional wells to the north of Grand Central Parkway, in the Fresh Meadows, Utopia and Cunningham Park, Alley Park locality, should be explored as a potential source of higher quality water.

INTRODUCTION

The Jamaica Water Supply Company (JWSC) depends for its primary source of supply on 76 wells in Queens County and 24 wells in Nassau County. The average daily production from these wells in 1982 was 82.2 million gallons. Peak demand is met through maximum use of these wells, plus purchase of water through interconnections with the New York City system. The locations of well stations are shown by Plate 1.

During 1982, a total of 14 wells were shut down due to concentrations of VOCs (volatile organic compounds) in excess of the New York State drinking water guidelines, 7 wells more than in 1981. One additional well has been closed in 1983. The aggregate lost yield capacity to date is approximately 14 mgd (million gallons per day). Concern about this adverse water-quality trend and lost productive capacity led to the present investigation, the primary purpose of which is to assess the vulnerability of other wells to contamination, and the adequacy of JWSC plans for further interconnection with the New York City system, and well-improvement and water-treatment alternatives in light of that anticipated vulnerability.

The study was proposed as joint effort by Leggette, Brashears & Graham, Inc. (LBG) and sub-consultant August A. Guerrera, Consulting Chemist, by letter dated March 11, 1983. The study was authorized on March 22, 1983. Work was initiated by study of documents of previous work provided by JWSC and by a "kick-off" data collection meeting at the JWSC offices on March 29.

The study has been carried out almost entirely on the basis of data available at the start of the study, in the form of published and unpublished reports, pumpage and water-level records, water-quality analyses available from several sources and discussions with JWSC personnel. The only field work was inspections of the locality of each JWSC well station to assess the land use and its probable relationship to water quality.

HYDROGEOLOGIC SETTING

The geology of the JWSC territory in Queens and western Nassau Counties has been covered in detail in numerous past reports and is outlined only briefly here as a framework for the study at hand. The area is part of the glaciated region of the Atlantic Coastal Plain, and as such has highly-pervious surficial soils and is underlain by substantial thicknesses of sand and gravel, interbedded with finer deposits of silt and clay.

The land surface ranges from sea level at Jamaica Bay to more than 170 feet above sea level along the Harbor Hill terminal moraine. Crystalline bedrock lies at elevations ranging from about 350 to almost 1000 feet below sea level within the franchise area. Between the land surface and bedrock are four identifiable aquifer units composed of unconsolidated sand or sand and gravel. The stratigraphy is illustrated by figure 1, generally north-south and east-west cross-sections through Central Queens. The north-south section shows the characteristic thickening wedge of sedimentary strata dipping toward the Atlantic Ocean.

The surficial aquifer is a glacially-derived sand and gravel consisting of outwash and terminal moraine sediments. Known as the Upper Glacial or Post-Jameco unit, the sediments range from silt to coarse gravel and rarely contain recognizable clay beds. Although the aquifer is relatively shallow, its high transmissivity results in excellent well productivity. The Upper Glacial has been pumped for many years at rates somewhat exceeding the average recharge rates, and as a result the regional water table is depressed throughout the JWSC territory, and particularly in central Queens, to the extent that once-productive wells now yield a

GENERALIZED GEOLOGIC CROSS-SECTIONS

from

WATER RESOURCES INVESTIGATIONS 77-34

EXPLANATION

SECTIONS

QUATERNARY

- Qu / Qc — Upper Pleistocene deposits
- UNCONFORMITY
- Qg — Gardiners Clay
- Qj — Jameco Gravel

UNCONFORMITY

CRETACEOUS

- Kmm — Magothy Formation-Matawan Group undifferentiated
- DISCONFORMITY
- Krc — Clay member
- Krl — Lloyd Sand Member

UNCONFORMITY

PRE-CAMBRIAN ?

- pЄ? — Bedrock

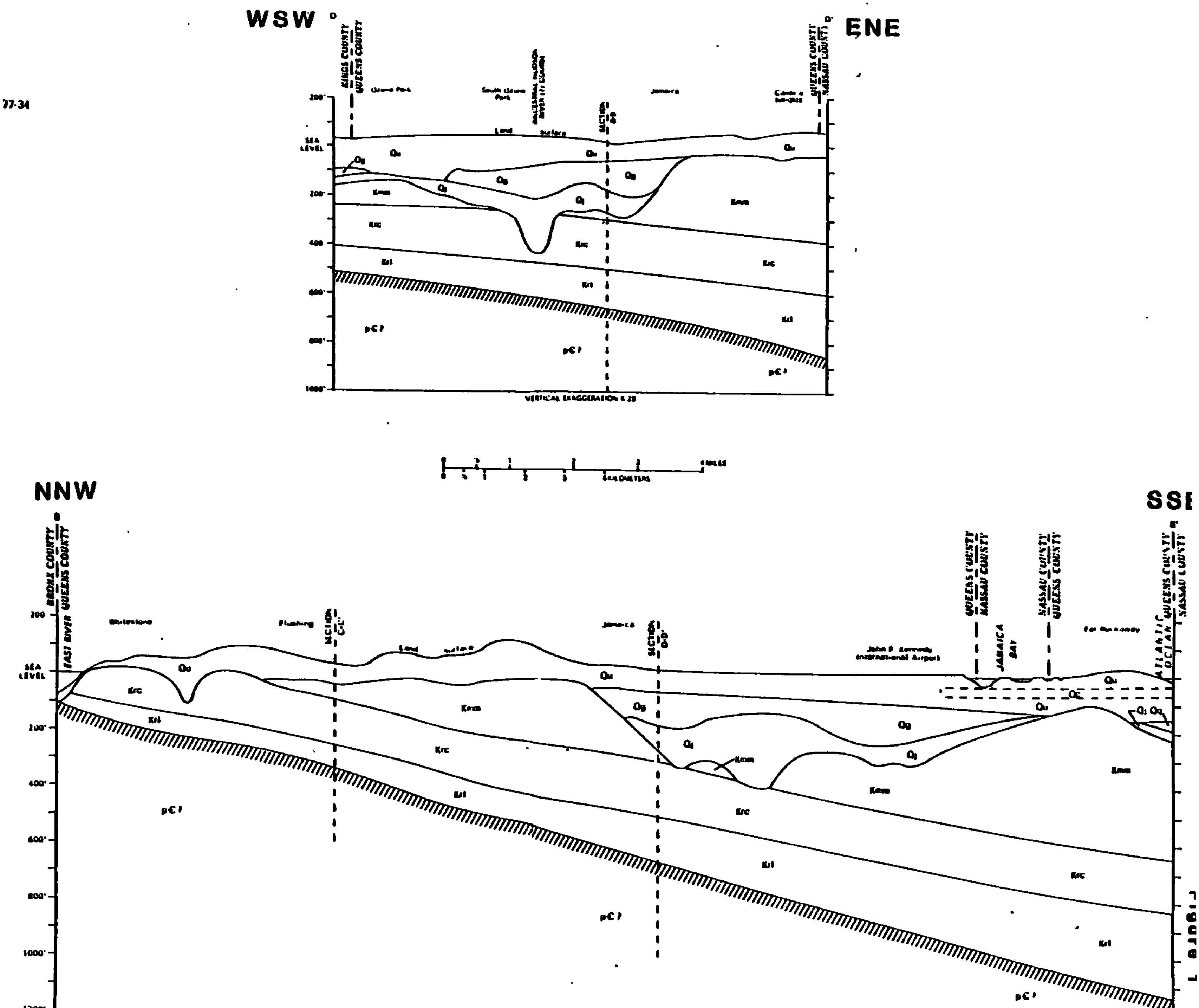

Figure 1

fraction of their former capacity, and some have been precluded from use due to the water table falling too low into the well screens.

The Jameco Gravel Aquifer is an older glacial sand and gravel that occurs only locally, mainly as deposits in buried valleys. The Jameco is almost everywhere overlain by the Gardiners Clay, at least within the JWSC territory. The Gardiners Clay is an effective aquiclude, a formation that severely restricts the vertical flow of water. Due to the high transmissivity of the Jameco, well productivity is high.

The Magothy Formation represents the upper aquifer of the Cretaceous-age sediments. The formation consists of fine to coarse sand, with little gravel and much interbedded clay and silt. The aquifer generally has lower hydraulic conductivity (permeability) than the glacial units but wells obtain the benefit of relatively high transmissivity by utilizing greater thicknesses of aquifer with fairly long well screens. In places the Magothy lies beneath the Gardiners Clay, in places it contains thick clays within its sediments, but in some locations there is virtually no effective hydraulic separation between the Magothy and the Upper Glacial.

The basal aquifer is the Lloyd Sand Member of the Raritan Formation, which is overlain in most places by the Raritan Clay. The Lloyd consists of sand and gravel, produces high well yields and is well protected from contamination. The aquifer is tightly confined, pumpage produces large areal drawdown, and further development of the Lloyd is restricted by the State.

All of the aquifer units on Long Island are hydraulically interconnected to some degree, but the presence or absence of tight clays and the hydraulic gradients control the rate of vertical water movement. Thus, the accumulated data on the occurrence of clays and the available data on head relationships between aquifer zones is a key element of the hydrogeologic setting in relation to the potential for organic chemical contamination.

EVALUATION METHODS

The procedure involved in assessing the vulnerability of individual JWSC wells to contamination was essentially to assemble all of the available data and then make a balanced judgmental evaluation of the degree of risk. To assist in the assessment process, the JWSC territory was subdivided into four arbitrary subregions having somewhat similar characteristics; West Sector, North Sector and East-Central Sector of Queens, and Nassau County, as indicated on Plate 1.

The factors considered included hydrogeologic factors, water-quality history, environmental influences and pumpage patterns, as noted below:

Hydrogeologic Factors:

1. Aquifer Unit - The Upper Glacial Aquifer, also known locally as the Post-Jameco Aquifer, is a very pervious outwash and terminal moraine deposit that provides very little retardation of vertical flow, mostly afforded by the vertical permeability of the granular deposits being less than the horizontal permeability. The other aquifers more commonly include clay laminations that retard vertical flow, and occur at greater depth from the surface sources of contamination.

2. Clays - The presence or absence of clays and their thickness is an important consideration. In the southwestern area, the Gardiners Clay is an excellent aquiclude over the Jameco and Magothy Aquifers, providing strong protection against organic contamination. The approximate limit of and area underlain by the Gardiners Clay is shown

on Plate 1. Elsewhere, clays within the Magothy can be good vertical flow barriers but their areal extent, or lenticularity, is unknown at any given site. The Raritan Clay Member overlies the Lloyd Aquifer in most areas and several other clays generally occur between the surface and the Lloyd Sand.

3. Flow Gradient - Where more than one well exists at a given station, with screens in two different depth zones, the elevations of static water levels and pumping water levels can be used to determine whether the leakage potential between aquifer zones is upward or downward. As a result of long-term pumpage, the prevailing vertical gradients have little relation to natural recharge or discharge areas, but are controlled by pumpage patterns.

4. Flow Direction - Through use of JWSC data and observation wells, the U. S. Geological Survey has periodically produced potentiometric maps for the Upper Glacial and Magothy aquifers. From these, the regional flow direction, upon which the cone of depression of an individual well is imposed, can be determined. The dominant directions of flow in the Upper Glacial Aquifer are indicated by arrows on Plate 1.

5. Screen Setting in Relation to Water Level - Many of the Upper Glacial wells have been dewatered by long-term pumpage to the extent that the pumping water level, or even the static water level, is below the top of the screen. In such cases, the potential for rapid migration of contaminants directly to a well screen exists.

A summary of these hydrogeologic factors for each well is given by table 1.

Water-Quality Factors

1. Organic Chemical History - Obviously a key consideration is whether any well has shown detectable concentrations of volatile organic constituents and if so, what concentrations and trends of concentrations have been occurring over time. The organic chemical quality of each well is summarized in table 2, and a chronological history of the laboratory analyses is given in Appendix II.

2. Nitrate-Nitrogen - Nitrates in ground water are mainly derived from human and animal wastes and from fertilizers, and are quite persistent once in the zone of saturation. The presence of high nitrates in some Magothy wells was used to assist in the assessment of the effectiveness of lenticular clays as barriers. In addition, it is noted that water from some wells in Queens exceed the New York State potable water standards for nitrate-nitrogen, and only stay beneath that standard by blending with other waters. Pertinent nitrate data are summarized in table 2.

3. Chlorides and Sulfates - Increasing trends of chlorides and sulfates are indicators of mixing with tidal salt water. These trends have been noted in southern, western and northern Queens but appear to have no relationship to organics contamination. However, where chlorides alone show increases, a likely cause is road salt, indicating a potential for organics to follow a similar travel path. Pertinent data for these constituents are given in table 2.

4. Iron - Iron content is high in a number of wells and iron treatment plants are in use. Trends of iron increase can be significant if treatability becomes adversely affected. Notes regarding significant iron content are given in table 2.

Environmental Influence

There is little evidence to prove that a single plume of contaminants has affected more than one well station but in some closely-spaced groupings of well fields, that might be the case. It is also possible that shutdown of contaminated wells and increased pumpage from neighboring wells may induce migration of VOCs that would not otherwise occur. Nevertheless, it appears from this study that an important consideration is local land use within several blocks - say, 1000 to 2500 feet - of a well. Where such localities are entirely residential there is rarely an organic contamination concern, and where certain types of commercial-industrial development are present, some contamination of at least the Upper Glacial Aquifer is common.

Pumpage Patterns

In considering the hydrogeologic setting, the water-quality history and the environmental influences, the degree of use of a well or well field has some bearing. A well that has a good record while pumped almost constantly is a better risk than a similar well that has not been so stressed by pumpage. Where contamination has occurred, changes in the pumping pattern, in both the horizontal and vertical sense, can influence the migration of contaminants. A summary of the well capacities and the recent data on metered pumpage is given by table 3.

ASSESSMENT OF VULNERABILITY OF WELLS TO ORGANIC CONTAMINATION

For the purpose of classifying the JWSC wells into categories of vulnerability to contamination by volatile organic compounds, a 5-category sorting was derived, based on the factors described above.

Class I includes those wells regarded as secure beyond any reasonable concern regarding organic chemical contamination. (In accepting this secure class, it must be noted that there have been several cases elsewhere of "secure" wells having been contaminated by causes that remain baffling after investigation.) This category includes Lloyd wells, Magothy and Jameco wells protected by the Gardiners Clay, deep Magothy wells with good protection and quality histories, and other wells whose local environment is entirely residential.

Class II is a category of low risk of organic chemical contamination. Separation of Class II from Class I generally involved small concerns about such factors as the local environment, low-level organic presence, organics in the shallow zone, and downward flow gradients, without any well-defined belief that an identifiable threat exists.

Class III represents wells deemed to have a moderate risk of future organic chemical contamination. Wells placed in this category generally are in commercial-industrial neighborhoods, have nearby or overlying wells with worrisome organic content and flow conditions favorable for migration, or have increasing levels of organics in recent analyses. In our judgment, some small percentage of these wells, say 20 to 30 percent, are likely to produce raw water with organics in excess of the New York State guidelines in the next several years, but clear identification of which individual wells might be affected cannot be established.

Class IV is the high-risk category, and includes wells for which the reason for present acceptable water quality is not clear in view of adverse conditions, where present organic concentrations are marginal, and where our best judgment indicates that high levels of contamination are likely in the future, even requiring closure of some wells within 1983.

Class V represents wells already closed and in one case, Well 31, a well that presently exceeds the drinking water guidelines for organics but which probably delivers water within standards after on-site blending and aeration. This well is regarded as closed, because it should be until proof of the quality of the delivered water is established.

The application of this assessment classification system to the JWSC well supplies is summarized by table 4, in which the rated capacity of each well is listed under the category in which the well was placed. The distribution of these categories is illustrated by Plate 2. Discussion of our rationale for classification of wells in Classifications V, IV and III in each sector of study follow:

WEST SECTOR - QUEENS COUNTY

Wells in Category V:

Well No. 8, closed since September 1981 because of excessive concentrations of TCE and PCE, generally improves when shut down over the winter months. There is a considerable advantage in that this well water is mixed with other waters in Richmond Hill prior to aeration for iron removal. The treated water produced should be analyzed in some detail to determine the effectiveness of this process in reducing these compounds, as well as the trichlorofluoromethane in Well No. 31. It may be possible to establish operational controls or protocols so that Well No. 8 and Well No. 31 cannot operate unless Well Nos. 17 and 17A are already producing water to the aeration treatment unit and distribution system. The quality of the post-aeration water should be monitored regularly and reviewed with the NYCHD (New York City Health Department).

Well No. 41, closed since September 1981 because of 200 ug/l of (micrograms/liter) TCE and 20 ug/l PCE will be more difficult to recover, being a single-well installation on a relatively small plot with little space for a treatment unit, since the air-stripping process would require a wet well and booster pumping station in additional to the aeration tower.

Well No. 31 contains trichlorofluoromethane, which was observed as an unidentified peak on earlier chromatographs, and first identified through mass spectrometry in 1982. As discussed earlier, the concentration of this compound may be reduced in the aeration process of the iron removal plant, and analyses should be performed on the treated water at this site. It has been reported that this site is within short distance of a railroad-car washing facility where detergents and organic solvents are used. Recent actions by the NYCHD have required recycling of these chemicals and connection of overflow to the sanitary sewers.

Wells in Category IV: None

Wells in Category III:

Well No. 1 is considered of moderate risk because of commercial and industrial land use in vicinity of the well field and increasing inorganic constituents, especially chloride and sulfate.

Well No. 4 is considered a moderate risk because of land-use patterns, the presence of moderate concentrations of VOCs and poor inorganic chemical quality, with nitrate-nitrogen concentrations greater than 10 mg/l (milligrams per liter) since 1975.

Well No. 32 is considered in this category although there has been an apparent improvement in organic contaminant concentrations. The nitrate-nitrogen average annual concentration has ranged 8.6 to 11.3 mg/l, and there is no other water available for blending.

Wells No. 43 and No. 45 are in this category because of the presence of moderate levels of organic solvents and deteriorating quality of inorganic constituents including chloride, sulfate and nitrate.

NORTH SECTOR - QUEENS COUNTY

<u>Wells in Category V</u>: None

<u>Wells in Category IV</u>: None

<u>Wells in Category III</u>:

Well No. 37 is assessed to be in the moderate risk category because of the consistent presence of moderate concentrations of PCE, even though located in a residential area, and evidence of deteriorating inorganic chemical quality including chloride and sulfate.

Well No. 53 is also assessed in the moderate risk category for the same reasons. PCE levels in 1982 increased to 30± ug/l, and chloride and sulfate are at elevated levels for glacial aquifer waters.

EAST-CENTRAL SECTOR - QUEENS COUNTY

<u>Wells in Category V</u>:

Well Nos. 6 and 6D at the Jamaica iron removal plant have been closed for several years because of the presence of several hundred ug/l of PCE. These glacial wells were operated in conjunction with the Lloyd well prior to aeration in the iron removal plant. The same rationale which was applied to Station Nos. 8, 17 and 31 could be applied here.

Well Nos. 24A and 24B were closed in December 1982 at this station, which includes an aeration unit designed for carbon dioxide removal, following a sudden increase in the concentration of PCE to more than 100 ug/l. The potential for reduction of VOCs through the aeration process should also be investigated here. Modifications of the aeration process may provide sufficient improvement to warrant evaluation of the treated water as the mixture.

Well Nos. 29 and 29A in the Queens Village area have been closed for several years because of very high concentrations of PCE in both aquifers. The reported seasonal improvement in the quality of No. 29A after aeration, which allowed its reopening in 1981 and 1982 should be documented and studied further to determine if modifications in the aeration through the carbon dioxide stripping tanks could effect a seasonal recovery of this capacity.

Well No. 33 contains more than 100 ug/l of xylene reported by the NYCHD laboratory in September 1981 after an upgrading of their instrumentation capabilities. The mixture of low levels of toluene, and several benzenes strongly indicates gasoline contamination even though no filling stations were in immediate proximity. It is recommended that no other action be taken other than operating the well to waste for an eight-hour period once a year and analyzing for VOCs and xylene, benzene and toluene (XBT).

Well No. 47 was closed in February 1983 following the detection of a dramatic increase in PCE levels first noted in the Autumn of 1982. The treatability of this water by aeration, or possibly, a part of the produced water by synthetic resin, should be investigated to allow for blending with the excellent-quality Magothy water available at the site. Based on presently-available data, there appears to be no need to design a treatment facility large enough for both wells.

Well No. 48A, screened in the upper part of the Magothy Aquifer, was closed October 1, 1981, reopened in 1982 and closed again October 4, 1982, because of the presence of PCE. There appears little likelihood that this well can be recovered because of the presence of PCE near 50 ug/l and nitrate-nitrogen above 10 mg/l in the Upper Glacial well above. Any treatment methodology to be investigated for this site should be sized to include both wells, and pumping schedules should continue to be closely controlled.

Well No. 49 was closed December 31, 1982, with a PCE concentration of 180 ug/l and nitrate-nitrogen of 8 mg/liter. The treatability of this well by aeration should be confirmed to verify favorable results obtained in February, so that this water may be utilized to blend with and reduce the nitrate-nitrogen level in the Magothy well at this site, which is already greater than Part 5 Standards.

Well No. 54 was closed on September 16, 1981, due to 120 ug/l PCE. The well has exhibited better quality when first utilized each summer in each of the past two years. Pumpage at reduced rates or for a restricted number of hours per day with frequent (several times weekly) analyses should be attempted to determine whether a lower withdrawal rate may allow use with quality within the guidelines. If this is not the case, treatability with air stripping should be investigated later this year, since the February results were inconclusive.

Wells in Category IV:

Well Nos. 6A and 6B have already been restricted due to high iron concentrations (9+ mg/l) and lost capacity. If Well No. 6B is treated to improve productivity, these wells may divert and capture high concentrations of VOCs already present in the Upper Glacial Aquifer at this site in Wells Nos. 6 and 6D.

Well No. 24C was placed in Category IV because of its relative location on the well field and because two other Upper Glacial Aquifer wells at similar depth are already closed because of PCE contamination.

Well No. 48 was considered in high-risk Category IV since it has produced water containing PCE near the guideline limit since 1979. Nitrate-nitrogen is near 10 mg/l and the Magothy well at this site is already closed due to the presence of PCE.

Wells in Category III:

Well No. 5 is classified in Category III because of its generally favorable local environment but the detected presence of traces of PCE in the deep well, No. 5A. The rated capacity is currently zero, due to the low water table in relation to the screen. JWSC plans to deepen this well to return it to service in 1984.

Well No. 49A is screened only about 60 feet below the bottom of Well No. 49, which has a PCE content exceeding 100 ug/l. There are separating clays and perhaps an upward gradient, but the nitrates are high. The consistently low VOC concentrations in water from No. 49A is the main reason the well is not in Category IV.

NASSAU COUNTY

Wells in Category V:

Well No. 16 has been closed since September 1978 with the detection of more than 300 ug/l of PCE. Frequent analysis during the early part of 1979 confirmed these concentrations, and this low-capacity well has not been operated since then.

<u>Wells in Category IV</u>:

Well No. 28 was closed in 1978 with the detection of more than 100 ug/l of TCE, and reopened in 1979. The well has had limited use since then, as has the deep Magothy well at the same location, which has moderately high iron. There is a large dry-cleaning establishment on Dutch Broadway, which may be a potential point source. Short-duration summer use of this well may continue to result in acceptable quality, but this well has a high potential for exceeding the "actionable guidelines" at any time.

Wells in Category III

Well No. 15C was placed in this category because of the land use in the vicinity and the fact that consistent low levels of VOCs are present in spite of the well being screened in the Magothy Aquifer. The trend of recent VOC concentrations are encouraging, but the security of this well would be increased if the planned redrilling includes completion at a deeper level in the Magothy.

Well No. 15D at this location, located across Hempstead Turnpike from the horse stables at Belmont Track, exhibits a continuing trend of increasing mineralization of the waters, especially nitrate-nitrogen which has been on the order of 9 mg/l since at least 1976.

Well No. 20 was placed in Category III even though inorganic and organic chemical quality is presently satisfactory. Our concern is based less on the landfill to the north, but the experiences with VOC contamination in the Magothy wells owned by the neighboring Water District immediately to the east. It is inferred from regional data that the direction of ground-water flow is westward.

Well Nos. 35 and 35A are considered in Category III because of the persistence of moderate concentrations of VOCs in both wells. Of special concern is that the Magothy well contains the higher concentration of TCE, (25-30 ug/l compared to 19 ug/l in the Upper Glacial well).

Well Nos. 40 and 40A are considered in Category III for the same reasons as above: persistent low concentrations of PCE and TCE in the shallow Magothy well and sporadic appearances of these chemicals in the deeper Magothy well. It is estimated that there is a vertical downward gradient at this location.

Well Nos. 57 and 57A are also considered in Category III because of the detection of VOCs, especially TCE in both wells. The presence of 30 ug/l of TCE and 9+

ug/l of nitrate-nitrogen in the Upper Glacial well, with these levels having increased in the past few years, is cause for concern. A downward gradient has been inferred at this site and the appearance of 20 ug/liter of TCE in the Magothy well tends to confirm this concern.

Assessment Summary

The data in table 4 indicate that 16 wells, 15 of which are in Queens, exceed the New York State "actionable guideline" for VOC contamination. These wells have an aggregate yield capacity of about 15.7 mgd. As discussed, it may be acceptable to operate certain wells, such as Well Nos. 8, 31 and, seasonally, 29A in the interim period until more extensive treatment is on-line in 1984 and 1985 by blending and the stripping resulting from the aeration treatment being employed for iron and carbon dioxide removal. This has the potential to restore as much as 4.1 mgd of the lost capacity, provided that the water delivered meets the VOC guideline. The potential for near-future deterioration of the VOC quality of Well No. 29A beyond feasible treatment remains questionable.

Our classification category of high-risk wells (Category IV) includes four wells in East-Central Queens, having a rated capacity of 5.0 mgd, and one well in Nassau, Well No. 28, with a rated capacity of 1.4 mgd. From an operational standpoint, these wells cannot be depended upon in 1983 and later years but this assessment should not be regarded as a prediction of certain productive loss in this time frame. Air-stripping, now in the planning stages, may return these wells to more dependable status.

The moderate risk classification (Category III) includes:

Area	Number of Wells	Rated Capacity (mgd)
West Sector	6	5.3
North Sector	2	2.1
East-Central Sector	2	2.3
Nassau	9	13.0
Total	19	22.6

Five of these Category III wells, are under study for air-stripping treatment. The uncertainty represented by this large number of wells and large production capacity is troublesome but no analytical procedure offers reliable prediction of how many and which wells in this category will be contaminated. Some wells in this category may have been classified unduly because of an inadequate data base or uncertainties about contamination sources. It is possible that the perceived moderate risk at some of this sites will be upgraded to low risk by ongoing monitoring data.

The remainder of the JWSC supply in Queens consists of 20 active wells having a total capacity of 33.1 mgd that are classified as secure (Category I) and 24 wells with a capacity of 29.4 mgd that are classified as low-risk wells (Category II). The Nassau situation includes 7 wells with a capacity of 13.7 mgd in Category I, and 6 wells with a capacity of 7.1 mgd in Category II.

ALTERNATIVE MITIGATION STRATEGIES

The mitigation of contamination of ground water resources by volatile organic compounds has been thoroughly discussed in the literature. (See papers in Journal AWWA by Dyksen or Ruggiero or Symons or Trussell). Several methodologies have been attempted here on Long Island, some on a pilot plant basis and a few on full scale. These strategies have been categorized into general groupings as follows, with their applicability to the Jamaica Water Supply Company's present problem areas.

I <u>Source Control Strategies</u>

- A. Upgradient or off-site Methodologies
  1. Detection and elimination of source
  2. Interceptor well or wells

- B. On-site Methodologies
  1. Develop pumping schemes to control or limit contaminant concentrations
  2. Blend with existing and/or new source
  3. Treat ground water to reduce contaminant level
  4. Treat produced water to reduce contaminant level before distribution
  5. Drill new well at existing or new site

II <u>Treatment Strategies</u>

- A. Aeration Treatment Techniques
  1. Slotted trays with counterflow air
  2. Diffused air system
  3. Packed columns with counterflow air

- B. Adsorption Techniques
  1. Granular activated carbon contactors
  2. Synthetic resin contactors

- C. Combination of Treatment Techniques

I <u>Source Control Strategies</u>

A. Upgradient or Off-site control measures

1. Detection and elimination of source

The detection and elimination of the source of the offending chemical contaminant is obviously the most efficient, cost-effective and longest-term solution. It is also the most difficult to accomplish. Every well field owned by JWSC was visited and each immediate neighborhood surveyed for potential sources of contamination. It is not considered possible to ascertain specific sources of VOC contamination at affected well fields. In some locations, for example, the areas surrounding the well fields, as at Nos. 8, 24, 29, 31 and 57, are so highly industrialized that there are multiple potential sources of contamination. Other sites such as well fields Nos. 16, 41, 47, 48 49 and 54 are surrounded by predominantly commercial and retail establishments, including gasoline filling stations, auto repair shops and dry cleaners. The potential for use of solvents, especially non-flammable degreasers, is large in these types of activities. There is great uncertainty as to the sources of volatile organic compounds detected in wells screened in Post-Jameco aquifer and located in essentially residential areas such as well fields Nos. 6, 33, 47 and 54.

Considerable effort would be required to accurately establish a point source for a specific compound at a specific site, since the volatile organic solvents in the chloroethane and chloroethylene families have specific gravities greater than 1.0 and tend to sink in the water column; they have long residence times in the aquifer because of relatively slow movements of the ground water; and they may also biodegrade in the presence of oxygen and aerobic bacteria so that the relative concentrations of compounds detected may be different than the ratio in the discharge stream. It is now postulated that the presence of the dichloroethylenes may result from the biodegradation of tetra and trichloroethylene, generally in their presence at higher concentration as at well fields Nos. 6, 8, 35 and 47. This may be of significance because the New York State Department of Health, in studying the toxicology of organic compounds, has indicated the possibility of lowering the "actionable guideline" for cis-1,2 dichloroethylene from 50 ug/l to 5 ug/l.

I A.2. Interceptor well or wells

With the absence of known or even strongly suspected point sources and with limited distances available outside the JWSC properties to even determine the direction and extent of a plume, the possibility of utilizing interceptor wells to remove contaminants from the ground water was given little consideration. However, containment and removal of part of the very high levels of PCE in Well No. 29 by pumping this well to waste may be beneficial for the long-term water quality of this well field.

I B. On-site Methodologies

1. Pumping schemes for "Plume Management".

It has already been established by JWSC staff that after resting wells No. 8, 41, 48A and 54 over the winter months, the first samples in the spring contain very low levels of the contaminant of concern. Objectionable concentrations are then detected later in the year after some undetermined volume is withdrawn from the aquifer.

It may be possible to recover some of this lost capacity if pumpages are reduced either by lower withdrawal rates or reduced hours of operation and frequent monitoring of the quality of the water produced. This practice was successfully utilized in several well fields owned by the Suffolk County Water Authority (especially at their Oval Drive and Locust Avenue well fields) by limiting the hours of operation per day and frequent sampling and analysis of the produced water. Well No. 48A is an exception, however, being screened in Cretaceous material, with water quality already deteriorated in the Post-Jameco well above in both organic and inorganic constituents. In the other three wells, however, all being Upper Glacial well installations with opportunities for blending, it may be possible to extend the service year.

Implementation of this technique should indicate the evaluation of the cost effectiveness of equipping and staffing the JWSC laboratory to include analyses of VOCs and XBTs by gas chromatography for all its wells.

I B.2. Blend with existing and/or new sources

Blending of water produced from wells has always occurred at some JWSC stations and is beneficial where moderate concentrations of VOCs are present in the shallow aquifer, as at well field Nos. 6, 8, 47, and 54, where deeper wells into either the Magothy or Lloyd Aquifer are available and of satisfactory quality. It should be noted, with considerable concern, that the potential for blending even in the summer months, may be more restricted in the future for Station Nos. 24, 29, 48 and 49, where organic chemicals are present in either all wells at the site or in the deeper aquifer as well, or at any station where present contamination levels may increase in concentration. The possibility is greater, however, for recovering some lost capacity at the iron and carbon dioxide removal plants where aeration is already practiced, such as at Richmond Hill where output from Station Nos. 8, 17 and 31 are mixed before treatment; and possibly at Station No. 6 as well.

Recent unrelated contacts with New York State Health Department personnel indicate that the practice of blending for VOC reduction in delivered water would be acceptable, but it has not been endorsed by local health agencies.

It should be noted, also that the New York State Health Department, in its report to Governor Cuomo discussing the Jamaica Water Supply Company, continued to encourage the practice of blending of several wells output to control the concentrations of nitrate-nitrogen. The same rationale should apply to the blending and treatment of waters containing moderate concentrations of VOCs, especially since the toxicological effects for VOCs are less well established and that no standards have been promulgated, but only "actionable guidelines". With the excellent organic-chemical quality water available in the deeper aquifers at Station Nos. 16 and 28, the blending issue might be successfully pursued with the Nassau County Health Department, especially if more wells degrade in Nassau County and production capability becomes an issue.

I B.3. Treat ground water to reduce contaminant levels

At several locations in Florida and Connecticut and in one very successful application at a site in Suffolk County, the affected ground water was pumped to the surface, sprayed into the atmosphere, and aerated and recharged to the ground through a recharge basin. Within a relatively short time the water entering the well screen had improved sufficiently to allow the water to be pumped into the distribution system. Implementation of this alternative would be limited since it would require a large plot to accommodate a recharge basin, relatively shallow wells with a minimum thickness of unsaturated material above the screen.

The most seriously-affected well fields of adequate size, such as Station Nos. 6, 8 (treated at Station No. 31), and 24 already have aeration facilities for iron and carbon dioxide removal treatment. It should not be discounted however for future use at well field Nos. 15 and 44, and the tank site at Station No. 28.

I B.4. Treat produced water to reduce contamination

Treatment strategies such as air stripping and granular activated carbon will be discussed in the next section. Unfortunately, most the results of the pilot air stripping testing conducted on nine JWSC wells in February 1983 were inconclusive. Although the possibility was anticipated by Mr. Becker in his correspondence with the contractor, Wells Nos. 8, 29A, 48A and 54 were not operated sufficiently long to obtain concentrations equivalent to those present prior to shut-down the previous October. The concentration of the Freon-11 compound Trichlorofluoromethane in Well 31 is recognized as a cause for concern and has been scheduled for air-stripping design. The concentration of tetrachloroethylene has continued to reduce in Well No. 32 since it exceeded the guideline in November 1979 even though it has operated continuously since May 1981. Only in Wells 47 and 49 were removals near 90 percent of the PCE present obtained. The favorable Henry's constant for PCE, and the moderate concentrations near 100 ug/l make these wells the more likely candidates of those tested so far.

The proposal to pilot test the remaining wells listed in Mr. Becker's report (6, 6D, 24A, 24B, 33 and 41) should be carried out along with a repeat of Well Nos. 8, 29A, 48A and 54 later in the pumping season.

With the successful reduction reported in the concentration of PCE and TCE in Well No. 29A after aeration, the JWSC should sample and analyze the treated waters from each of the other iron removal plants where contributing wells contain VOCs, to determine their concentrations in the mixed treated supply entering the distribution system. The data may be favorable enough to warrant an application to NYCHD to judge the water quality in the distributed water as presently required by the Safe Drinking Water Act and Part 5 of the State Sanitary Code, rather than only at the well-head. Applicable sites include Station No. 6 and the 8, 17, and 31 grouping.

I B.5. Drill new well at existing or new site

Most of the presently-affected well fields already contain wells screened in two aquifers, i.e., Station Nos. 6, 8, 29, 47, 48, 49 and 54. New well-field sites may be considered outside the assigned service area, especially in northeast Queens County.

II <u>Treatment Strategies</u>

A. Aeration Treatment Techniques

There is extensive literature on aeration practices especially in the Northeast and Southeast United States. This technique has operated successfully in pilot testing and some full scale projects especially where the contaminant is as easily stripped as is tetrachloroethylene. Since the VOC of highest concentration and greatest frequency of occurrence is PCE in 12 of the 15 wells now out-of-service, JWSC should continue to pursue its pilot feasibility studies on aeration but with greater control over the analytical aspect, including a thorough reevaluation of the potential cost-benefits of establishing its own gas-chromatography capability. The value of in-house analytical capability should not only consider savings in terms of dollars per analysis, but the considerable advantage of quality assurance as measured by precision and accuracy of results, and the additional operational flexibility with the ability to monitor variations in VOC concentrations with withdrawals.

The same instrumentation could be utilized to analyze for the xylenes, benzene, and toluene, which all have specific gravity less than water, and tend to occur near the surface of the water table. These compounds may represent a threat to the Post-Jameco wells which has not been adequately addressed. Since these low-density compounds are generally not considered "chlorinated hydrocarbons" as are other VOCs, the guideline applied would most likely be 5 ug/l rather than 50.

II A.1. Slotted trays with counterflow air

The Company already operates two slotted-tray aerators, constructed for carbon-dioxide reduction at stations where VOCs are present in the well water. Design modifications of these facilities should be investigated as a means of increasing the transfer of the VOC present across the air-water interface.

II A.2. Diffused air injection

Diffused air injection has been practiced elsewhere where a large storage facility is available, but has not been efficient where there is a rapid turnover of water in storage. In any event, it can only be considered at those locations where there is an underground storage facility available at the same station where VOCs are present in the well water. This is the case at Station Nos. 29 and 35, for example. However, this process is very energy intensive, so that operating expenses generally make it unattractive compared to packed columns.

II A.3. Packed columns with counterflow air

As discussed in the previous section, aeration by cascading water through packed columns with counterflow air at ratios of 20:1 to 40:1 volumetrically, is recognized industry-wide as an economical method for reducing VOC concentrations by enhancing the transfer of these compounds across the water-air interface. The Company already has plans to continue pilot-plant investigations, and to proceed with design and construction of full-scale treatment units.

Separate aerators for the removal of TCE from Well 8 and the Freon compound from Well No. 31 prior to iron removal would require more detailed study than a one-day study with several air-water ratios. The Henry's Constant (or volatility driving force) for TCE is only one-half that for PCE; and that for carbon tetrachloride or chloroform, which are closer in chemical structure to Freon 11, is only one-tenth of that of PCE. At especially these sites, a packed column of greater diameter with greater height and an intermediate sampling point should be specified so that mass transfer coefficients may be calculated with more certainty. These measurements would be critical in design of a full scale treatment unit for these more difficult to treat compounds.

II B. Adsorption Techniques

1. Granular Activated Carbon Contactor: The use of GAC in the past has been limited, along with powdered activated carbon where coagulation and settling are practiced, to taste and odor removals. During the last decade, its use for controlling and removing organic compounds has increased. It has most recently been used most effectively on Long Island to treat ground waters near Greenport for removal of the pesticide, Aldicarb. Adsorption on carbon is most

effective with compounds of low solubility, high molecular weight, low or non-polarity. Tetrachloroethylene is most easily adsorbed of the compounds found in JWSC wells, with trichloroethylene less so, and the saturated methane (Freon 11) even less. The capacity of Well No. 33 appears too small to warrant even the investigation of GAC to remove xylenes present. The procedure is very capital intensive, requiring large contactors with empty bed contact times of 10-13 minutes commonplace, but most critically, the necessity to store, replace and/or regenerate spent carbon offsite on an unknown frequency to be determined by routine monitoring and analyses.

II.B 2. Synthetic resin contactors: A recent Federally-supported study (Glen Cove) demonstrated the feasibility of selecting specific reticular absorbent resins which are efficient in removing low molecular weight organics such as the organic solvents. Pilot column tests are also always required. Even though the resins are much more expensive than carbon, they may be more attractive due to lower capital and operating expense. Contact times necessary are much shorter, therefore requiring smaller equipment; higher absorption capacities necessitate less frequent regeneration and most importantly, regeneration of the resin may be effected in place with steam.

II C Combination of Techniques

The selection of an alternative or combination of alternatives would depend on the mixture of contaminants, relative treatability of each, relative concentrations of each compound, space available, capacity of wells, etc. Well Field No. 29 for example, may be treatable with a combination of aeration and adsorption.

ADDITIONAL RECOMMENDATIONS

1. JWSC is planning VOC treatment by air-stripping at eight stations; Nos. 29, 31, 35, 47, 48, 49, 54 and 57. Our recommendations relative to these plans are as follows:

Station No. 29:

Present plans call for drilling a replacement well for Wells No. 29 to the deep Magothy, at greater depth than Well No. 29A, and providing a VOC-treatment facility for both Magothy wells to be on-line by April 1984. Coupled with this plan are conditional plans to pump Well No. 29 to waste to remove VOCs from the shallow aquifer and to minimize downward migration. Considering the exceptionally high concentrations of PCE in Well No. 29, the VOC history of Well No. 29A, the downward flow gradients regardless of whether Well No. 29 is pumping, and the uncertainty whether the deep replacement well would have adequate stratigraphic protection or would itself become contaminated, it is recommended that plans for the drilling and treatment facility be deferred and reevaluated. The pumping of Well No. 29 to waste is recommended as a means to remove heavily-contaminated water, minimize downward migration and limit lateral migration to other shallow wells. Periodic VOC sampling of Well Nos. 29 and 29A should be done to monitor change in this contamination situation.

Station No. 31:

Present plans include design and construction of an aeration facility, for Well No. 31 to be on-line April 1985. Since other similar one-carbon compounds such as chloroform and carbon tetrachloride have Henry's Constants reported in the literature that are much lower than PCE or TCE, it is recommended that additional pilot-plant investigations be carried out, with specifications to include a taller column with intermediate sampling ports. Mass transfer coefficients then calculated can be utilized to design a packed column. Consideration should be given to the advantage of mixing this aerated water with waters produced from Well Nos. 8, 17 and 17A.

Station No. 35:

Station No. 35 is planned for pilot testing for air-stripping feasibility in early 1984. Since the Magothy well has higher concentrations of TCE than the Upper Glacial well, an unusual condition, we recommend that both wells be evaluated and that the treatment facility be designed for the capacity of both wells.

Station No. 47:

Present planning indicates the design and construction of an aeration-treatment facility to treat both wells at this location to be on-line by December 1984. We recommend that pilot studies be carried out on Well No. 47 and a treatment facility be designed and constructed in concurrence with your plan. We recommend, however, that similar activities be deferred for Well No. 47A since there is no contamination presently evident, several clay aquicludes have been identified overlying the Magothy Formation and the good inorganic chemical quality does not indicate substantial downward leakage at this location.

Station No. 48:

We recommend that this station be given high priority in the pilot air-stripping studies, with design and construction of a treatment facility to treat both wells by April 1984 in concurrence with JWSC present planning. The higher concentrations with seasonal variations, of PCE in the Magothy well together with PCE near the guideline and nitrate-nitrogen over the standard in the Upper Glacial well, make resolution of the VOC problem more immediate in order to continue the viability of blending for the inorganic constituent.

Station No. 49

We concur in present planning to pilot-test, design and construct a packed column air-stripping facility to treat the combined output of Well Nos. 49 and 49A. The presence of low levels of PCE and high levels of inorganic constituents in the Magothy well can only be exacerbated by preferential pumping of the deep well.

Station No. 54:

Present planning for design and construction of a packed-column aeration unit to be on-line by the 1986 season is concurred, considering the excellent quality water available in the Magothy well from both inorganic and organic standpoint.

Station No 57:

Pilot air-stripping for both wells at this location is presently planned for early 1984. We suggest that this investigation may be safely deferred for several years even though moderate levels of TCE are present in the Magothy wells. Both wells have contained consistent low levels of TCE for the past five years. In addition, the reliability of calculations of mass transfer coefficients may be less certain when the influent water to the packed pilot column contains less than 20 ug/l of the VOC to be removed.

2. JWSC is planning redrilling and/or deepening seven wells over the next two years in both Counties; Well Nos. 5, 7, 13, 15C, 19, 21 and 29. Our recommendations are supportive with the exception of Well No. 29 which has been discussed in the previous sections. Our recommendations relative to the remaining plans are as follows:

Station Nos. 7 and 21:

Both stations presently contain wells screened in the Magothy aquifer which deliver water of excellent quality, both from organic and inorganic viewpoints, and additional wells of similar depths are recommended.

Station No. 13:

The deepening of Well No. 13 into the Magothy formation should include planning to explore the formation to the Raritan Clays for the deepest possible screen setting. Well No. 13A, screened at -194 feet MSL, already contains low levels of PCE.

Station No. 5:

Present planning to deepen Well No. 5 to similar depth as Well No. 5A is concurred and recommended due to satisfactory quality water available in that formation.

Station No. 15:

We concur with present planning to deepen Well No. 15C to a depth at least equivalent to Well Nos. 15A and 15B which are screened as deep as -374 feet MSL. Water of satisfactory quality is presently produced from each of these wells.

Station No. 19:

A test well was drilled in 1929 to a depth of 640 feet through the Lloyd Sand. High levels of iron were reported from a test setting of 240 feet, but no firm data are available and it is not clear whether the water was ever free of turbidity which may have affected the iron determinations. In view of the uncertainties, the relatively low priority assigned to this project for completion in 1985 is considered reasonable.

3. Plans to activate additional interconnections with the New York City system in northeast and southeast Queens, each estimated to provide 3500 gpm or 5 mgd, will augment the supply in an area with many contaminated and high-risk wells. The opportunity to fully utilize these connections to rest wells prior to the peak-demand season may extend the useful seasonal life of marginal-quality wells in both Category IV and Category V during the supply stress of the next several summers.

4. The relatively high-quality water derived from wells in the North Sector of Queens, including Station Nos. 50-53 to the north of the franchise area, suggests that one or more additional well-field groupings might be developed north of the Grand Central Parkway in the Fresh Meadows, Utopia, Cunningham Park, Alley Park area. Land use in this general

area is largely residential and parkland, and the water table is above sea level. The technical, regulatory and economic feasibility of such additional wells should be considered for long-term water-supply improvement.

LEGGETTE, BRASHEARS & GRAHAM, INC.

R. G. Slayback

R. G. Slayback, CPG

and A. GUERRERA ASSOCIATES

August A. Guerrera

August A. Guerrera

dm
May 1983

REFERENCES

1. Buxton, Herbert T., Julian Soren, Alex Posner, and Peter K. Shernoff; 1981; U. S. Geological Survey, Open-File Report 81-1186; "Reconnaissance of the Ground-Water Resources of Kings and Queens Counties, New York"; Syossett, New York.

2. Henderson and Bodwell, October 11, 1977; "Report to the Jamaica Water Supply Co. On The Current Evidence Concerning Chloride Intrusion into the Post Jameco Wells of the Post Jameco Wells of the Company in the Queens Franchise Area". Plainville, New York.

3. Henderson, Bodwell; "Jamaica Water Supply Company Analysis Concerning New or Deepened Wells in the Magothy Strata"; Plainview, New York.

4. Henderson, Bodwell and Casey; "Ground Water Supply Available to Jamaica Water Supply Company"; Plainview, New York; Exhibit No. 1 and Exhibit No. 2H.

5. Laynco Environmental Products; Letter report dated May 4, 1983; "Report on Pilot Testing for Volatile Organics Removal; Linden, New Jersey.

6. New York State Department of Health, Bureau of Public Water Supply Protection, February 23,1982; "Briefing Document for Governor Cuomo, Jamaica Water Supply Company".

7. Malcolm Pirnie, Inc.; May 1983; " Control of Organic Chemicals in Ground Water Supply". (Draft)

8. Soren, Julian, 1971, "Ground-water and Geohydrologic Conditions in Queens County, Long Island, New York": U. S. Geological Survey Water-Supply Paper 2001-A.

9. Stern, Alan and Lori Todd, Environmental Toxicology Unit; January 1982; "Jamaica Water Supply Company Wells Sampling and Wellfield Survey 1981, Summary Report"; New York City Department of Health.

10. Wolfert, Michael F. and William J. Seevers, Geraghty & Miller, Inc.; September 15, 1980; "Hydrogeologic Evaluation of Jamaica Water Supply Company's Ground-Water Resources".

TABLE 1

JAMAICA WATER SUPPLY COMPANY

HYDROGEOLOGIC WELL DATA

TABLE 2

JAMAICA WATER SUPPLY COMPANY

SUMMARY OF WATER QUALITY - CONSTITUENTS OF CONCERN

TABLE 3

JAMAICA WATER SUPPLY COMPANY

WELL CAPACITY SUMMARY

TABLE 4

JAMAICA WATER SUPPLY COMPANY

ASSESSMENT OF VULNERABILITY
OF WELLS TO ORGANIC CONTAMINATION

Table 1

JAMAICA WATER SUPPLY COMPANY
HYDROGEOLOGIC WELL DATA

Well No.	Aquifer Screened 1/	Screen Setting (ft below sea level) 2/	Water Level In Screen? 3/ SWL	PWL	Vertical Gradient? Up/Down 4/	Overlying Clay?	Comments
			WEST SECTOR - QUEENS COUNTY				
1	UG	20 - 30	No	Yes	--	No	
3	UG	20 - 67	No	Yes	--	No	
3A	UG	93 - 121	No	No	Down	Yes	Clay (10')
4	UG	46 - 66	No	Yes	--	No	
8	UG	27 - 37	No	No	--	No	
8A	L	447 - 487	No	No	Down	Yes	Gardiners Clay (44')
11	J	185 - 235	No	No	--	Yes	Gardiners Clay (56')
14	J	218 - 268	No	No	--	Yes	Gardiners Clay (79')
17A	M	204 - 223	No	No	--	Yes	Gardiners Clay (52')
17	L	432 - 492	No	No	Down	Yes	Gardiners Clay (52')
22	UG	29 - 48	No	No	--	No	
31	UG	76 - 96	No	No	--	No	
32	UG	45 - 65	No	No	--	No	
41	UG	31 - 51	No	No	--	No	
43	UG	45 - 65	No	No	--	No	
43A	M	154 - 183	No	No	--	Yes	Gardiners Clay (57')
45	UG	72 - 118	No	No	--	No	Split screen
			NORTH SECTOR - QUEENS COUNTY				
18	M	82 - 122	No	No	--	Yes	
18A	L	410- 489	No	No	Down	Yes	
19	UG	8 - 20	No	Yes	--	No	
21	UG	9 - 6	--	--	--	No	
21A	M	149 - 189	No	No	--	Yes	Several clays
27	UG	47 - 69	No	No	--	No	

Well No.	Aquifer Screened 1/	Screen Setting (ft below sea level) 2/	Water Level In Screen? 3/ SWL	PWL	Vertical Gradient? Up/Down 4/	Overlying Clay?	Comments
37	UG	47 - 85	No	No	--	No	
50	UG	70 - 86	No	No	--	No	Clay streaks
50A	M	146 - 181	No	No	Up/Down	Yes	Several thin clays
51	M	142 - 208	No	No	--	Yes	Several clays
52	UG	59 - 69	No	No	--	Yes	Several thin clays
53	UG	54 - 74	No	No	--	Yes	
53A	M	145 - 189	No	No	Up	Yes	Several clays
58	M	158 - 208	No	No	--	Yes	Clays (110'+)
			EAST - CENTRAL SECTOR - QUEENS COUNTY				
5	UG	+3 - 31	Yes	Yes		No	
5A	M	171 - 223	No	No	Up/Down	Yes	Several thin clays
6	UG	19 - 42	No	Yes	--	No	
6A	UG	24 - 47	No	Yes	--	No	
6B	UG	37 - 64	No	No	--	No	
6D	UG	38 - 58	No	No	--	No	
6C	L	507 - 576	No	No	Down	Yes	Gardiners clay (53')
7	UG	16 - 26	No	--	--	No	
7A	UG	42 - 59	--	--	--	Yes	Clay (14')
7B	M	173 - 216	No	No	Down	Yes	Several thin clays
10	UG	14 - 57	No	--	--		
10A	M	336 - 388	No	No	Down	Yes	Several thin clays
13	UG	+23 - 14	Yes	Yes	--	No	
13A	M	175 - 194	No	No	Up/Down	Yes	
23	UG	17 - 39	No	--	--	Yes	
23A	M	243 - 304	No	No	Down	Yes	
24	UG	25 - 35	No	No	--	No	Gardiners Clay at -26'
24A	UG	11 - 25	No	Yes	--	No	Gardiners Clay at -28'
24B	UG	14 - 33	No	Yes	--	No	Gardiners Clay at -34'
24C	UG	13 - 31	No	Yes	--	No	Gardiners Clay at -33'
26	UG	39 - 59	No	--	--	Yes	Sandy clay (6')
26A	M	184 - 222	No	No	Down	Yes	Several clays
29	UG	10 - 28	No	--	--	No	
29A	M	168 - 208	No	No	Down	Yes	Several clays

Well No.	Aquifer Screened 1/	Screen Setting (ft below sea level)2/	Water Level In Screen? 3/ SWL	PWL	Vertical Gradient? Up/Down 4/	Overlying Clay?	Comments
33	UG	28 - 48	No	No	--	No	Black clay (1')
36	M	359 - 393	No	No	--	Yes	Several clays
38	UG	33 - 53	No	No	--	No	
38A	M	181 - 221	No	No	Down	Yes	Several clays
39	UG	+1 - 20	No	Yes	--	No	
39A	M	141 - 182	No	No	Down	Yes	Several clays
42	UG	27 - 37	No	--	--	No	
42A	M	192 - 232	No	No	Down	Yes	Several clays
46	UG	42 - 61	No	--	--	No	Two 1' clays
47	UG	29 - 50	--	--	--	No	
47A	M	249 - 289	No	No	--	Yes	Several clays
48	UG	39 - 59	No	No	--	No	Clay (1')
48A	M	179 - 219	No	No	Up	Yes	Several clays
49	UG	43 - 64	No	--	--	No	
49A	M	123 - 163	No	No	Up	Yes	Thin clays
54	UG	39 - 49	No	--	--	No	
54A	M	267 - 307	No	No	Down	Yes	Several clays
55	M	184 - 224	No	No	--	Yes	Several clays
56	M	380 - 420	No	No	--	Yes	Several clays
59	M	345 - 395	No	No	--	Yes	Split screen; clays
60	M	262 - 310	No	No	--	Yes	Split screen; clays
			NASSAU COUNTY				
9	UG	+14 - 3	No	--	--	No	
15D	UG	21 - 45	No	--	--	No	
15A	M	334 - 374	No	No	--	Yes	
15B	M	320 - 369	No	No	Down	Yes	
15C	M	191 - 241	No	No	Up	Yes	
16	UG	+23 - 13	No	--	--	No	
16A	L	555 - 613	No	No	Down	Yes	Several thin clays
20	M	300 - 360	No	No	--	Yes	

Well No.	Aquifer Screened 1/	Screen Setting (ft below sea level) 2/	Water Level In Screen? 3/ SWL	PWL	Vertical Gradient? Up/Down 4/	Overlying Clay?	Comments
25	UG	31 - 51	No	--	--	No	
25A	M	363 - 403	No	No	Down	Yes	Several thin clays
28	UG	16 - 34	No	--	--	No	
28A	M	425 - 454	No	No	Down	Yes	Several clays
30	M	438 - 478	No	No	--	Yes	Several clays
34	M	412 - 466	No	No	--	Yes	Several clays
35	UG	+2 - 8	No	--	--	No	
35A	M	267 - 301	No	No	Down	Yes	Several clays
40	M	135 - 170	No	No	--	Yes	Several clays
40A	M	262 - 322	No	No	Down	Yes	Several clays
44	UG	+5 - 15	No	--	--	No	
44B	UG	3 - 23	No	--	--	No	
44A	M	226 - 260	No	No	Down	Yes	Several clays
44C	M	233 - 273	No	No	Down	Yes	Several clays
57	M	67 - 107	No	No	--	Yes	Several clays
57A	M	302 - 342	No	No	Down	Yes	Several clays

1/ UG - Upper Glacial Aquifer (Post Jameco)
J - Jameco Aquifer
M - Magothy Aquifer
L - Lloyd Aquifer

2/ Values shown as + are above sea level.

3/ Based on April 1980 data, as reported by Geraghty & Miller, Inc.

4/ Relationship of water-level elevation as compared to shallower well at same site; where dual entry is shown, first is static level gradient and second is operating condition; based on April 1980 data reported by Geraghty & Miller, Inc.

Table 2

JAMAICA WATER SUPPLY COMPANY
SUMMARY OF CHEMICAL QUALITY - CONSTITUENTS OF CONCERN

JWSC Well No.	NYSDEC Well No.	Aquifer 1/	Status	Environment	Organic Chemical of Concern: Compound	Organic: Concentration Range 4/	Organic: Trend	Inorganic Chemical of Concern: Compound	Inorganic: Concentration Range 4/	Inorganic: Trend
WEST SECTOR - QUEENS COUNTY										
1	Q301	UG		Commercial/ Industrial	ND	--	--	Cl	54-67	Incr.
								SO_4	110-120	Incr.
3	Q303	UG		Residential	ND	--	--	Cl	59-68	Incr.
								NO_3	10-11	Incr.
3A	Q558	UG		Residential	ND	--	--	NO_3	7-10	Incr.
4	Q304	UG		Apt. Houses	PCE	30	Incr.	NO_3	10-12	Incr.
8	Q308	UG	Off-9/81	Commercial/ Industrial	TCE	17-110	Incr.	Cl	58-77	Incr.
					PCE	12-32	Incr.	SO_4	84-98	Incr.
8A	Q565	L		Commercial/ Industrial	ND	--	--	Fe	0.7-0.8	Incr.
11	Q875	J	Repl.	Residential	ND	--	--	Cl	15-57	Incr.
								Fe	0.55-1.0	Incr.
								Mn	0.4-1.0	Incr.
14	Q314	J	Repl.	Residential	ND	--	--	Cl	40-63	Incr.
								Fe	0.4-0.6	Stable
								Mn	0.3-0.4	Stable
17A	Q566	M		Industrial	ND	--	--	Fe	1.7-3.3	Incr.
								Cl	29-141	Incr.
17	Q317	L		Industrial	ND	--	--	Fe	1.4	Stable

JWSC Well No.	NYSDEC Well No.	Aquifer 1/	Status	Environment	Organic Chemical of Concern Compound	Concentration Range 4/	Trend	Inorganic Chemical of Concern Compound	Concentration Range 4/	Trend
WEST SECTOR - QUEENS COUNTY										
22	Q322	UG		Commercial/ Industrial	PCE	8-33	Incr.	Cl SO_4	80-85 118-131	Incr. Incr.
31	Q1811	UG		Industrial	2/	90-220	Incr.	Cl NO_3	58-66 5.3-6	Incr. Stable
32	Q1840	UG		Commercial	PCE	9-40	Decr.	NO_3 Cl	8.6-11 57-62	Stable Stable
41	Q2006	UG	Off-9/81	Commercial	TCE PCE	46-480 12-180	Incr. Stable	Cl SO_4	83-110 100-130	Incr. Incr.
43	Q2138	UG		Residential	PCE	3-14	Stable	Cl	50-59	Incr.
43A	Q2332	M		Residential	PCE	1-4	Incr.	Fe	0.4	Stable
45	Q2189	UG		Residential	PCE	8-18	Stable	Cl NO_3	55-94 4.5-9.9	Incr. Incr.
NORTH SECTOR - QUEENS COUNTY										
18	Q2137	M		Residential	ND	--	--	Fe Cl	0.9-3.4 16-36	Incr. Incr,
18A	Q567	L		Residential	ND	--	--	Fe	1.6-2.2	Incr.
19	Q319	UG	Off-low water	Residential	ND	--	--	--	--	--
21	Q321	UG		Residential	ND	--	--	Cl NO_3	77-112 3-4	Incr. Stable
21A	Q2435	M		Residential	ND	--	--	--	--	Stable
27	Q1747	UG		Residential	ND	--	--	NO_3	1.7-3.5	Stable

JWSC Well No.	NYSDEC Well No.	Aquifer 1/	Status	Environment	Organic Chemical of Concern Compound	Organic Chemical of Concern Concentration Range 4/	Organic Chemical of Concern Trend	Inorganic Chemical of Concern Compound	Inorganic Chemical of Concern Concentration Range 4/	Inorganic Chemical of Concern Trend
37	Q2001	UG		Residential	PCE	13-19	Incr.	Cl	51-58	Incr.
50	Q2373	UG		Residential	PCE	2-4	Stable	Cl	56-77	Incr.
								SO_4	95-105	Stable
50A	Q2374	M		Residential	ND	--	--	Cl	±20	Stable
51	Q2362	M		Commercial/ Residential	PCE	10-38	Stable	--	--	Stable
52	Q2363	UG		Residential	ND	--	--	Cl	86-103	Incr.
								SO_4	96-106	Stable
53	Q2408	UG		Residential	PCE	7-38	Incr.	Cl	58-63	Stable
								SO_4	88-103	Stable
53A	Q2409	M		Residential	PCE	2-6	Incr.	NO_3	4.5-5	Stable
58	Q3014	M		Residential	ND	5-9	Incr.			Stable
EAST - CENTRAL SECTOR - QUEENS COUNTY										
5	Q305	UG	Off-low water	Residential	ND	--	--	--	--	--
5A	Q1957	M		Residential	PCE	5-8	Stable	Cl	27-32	Stable
6	Q306	UG	Off-9/81	Residential	PCE	130-390	Incr.	Cl	43-55	Stable
								SO_4	105-122	Stable
								Fe	2.5-4.5	Stable
6A	Q560	UG		Residential	PCE	3-5	Stable	Cl	31-50	Incr.
								Fe	9.2	Incr.
6B	Q561	UG	Off	Residential	--	--	--	--	--	--
6D	Q1839	UG	Off	Residential	PCE	65-300	Incr.	NO_3	5.5-7.0	Stable
								Fe	1.7-3.5	Stable
6C	Q562	L		Residential	ND	--	--	Fe	2.7-3.2	Stable

JWSC Well No.	NYSDEC Well No.	Aquifer 1/	Status	Environment	Organic Chemical of Concern Compound	Organic Concentration Range 4/	Organic Trend	Inorganic Chemical of Concern Compound	Inorganic Concentration Range 4/	Inorganic Trend
7	Q307	UG		Residential	ND	--	--	Cl	46-54	Stable
								NO_3	8.0-9.4	Stable
7A	Q563	UG		Residential	ND	--	--	Cl	37-45	Incr.
								NO_3	4.8-8	Incr.
7B	Q564	M		Residential	PCE	1-2	Stable	NO_3	5-7	Stable
10	Q310	UG		Residential	ND	--	--	NO_3	5-7	Stable
10A	Q1958	M		Residential	ND	--	--	--	--	--
13	Q313	UG	Off-low water	Residential	ND	--	--		--	--
13A	Q1600	M		Residential	PCE	2-5	Stable	NO_3	4.5	Stable
23	Q323	UG		Residential	ND	--	--	NO_3	5-6	Stable
23A	Q568	M		Residential	ND	--	--	NO_3	5-6	Stable
								Cl	78-82	Incr.
24	Q324	UG	Out-Ser.	Industrial	PCE	?	?	?		
24A	Q569	UG	Off-12/82	Industrial	PCE	16-150	Incr.	Cl	40-57	Incr.
								SO_4	72-90	Incr.
24B	Q570	UG	Off-12/82	Industrial	PCE	14-117	Incr.	Cl	30-43	Incr.
								NO_3	1.9-4.8	Incr.
								Fe	3.3-6.3	Incr.
24C	Q1058	UG		Industrial	PCE	1-3	Stable	Cl	31-47	Incr.
								SO_4	85-116	Incr.
								Fe	1.6-2.8	Incr.
26	Q1450	UG		Residential	PCE	1-4	Stable	Cl	52-55	Stable
								NO_3	4.4-7.1	Incr.
26A	Q1815	M		Residential	PCE	1-2	Stable	NO_3	2.5	Stable
29	Q1534	UG	Off-9/75	Industrial	PCE	120-15,000	Incr.	NO_3	9-9.2	Incr.
29A	Q1629	M	Off-12/82	Industrial	PCE	12-440	Incr.	Cl	30-57	Incr.
					TCE	6-65	Incr.	NO_3	6.6-7.6	Incr.

JWSC Well No.	NYSDEC Well No.	Aquifer 1/	Status	Environment	Organic Chemical of Concern: Compound	Organic Chemical of Concern: Concentration Range 4/	Organic Chemical of Concern: Trend	Inorganic Chemical of Concern: Compound	Inorganic Chemical of Concern: Concentration Range 4/	Inorganic Chemical of Concern: Trend
33	Q1843	UG	Off-9/81	Residential	Xylene	110-124	Incr.	Cl	33-57	Incr.
36	Q2026	M		Residential	ND	--	--	Fe	0.46	Stable
38	Q1997	UG		Commercial	PCE	3-7	Stable	Cl	61-69	Incr.
38A	Q2432	M		Commercial	PCE	2-4	Stable	--	--	Stable
39	Q2000	UG		Commercial	PCE	1-3	Stable	Cl	33-49	Incr.
39A	Q2188	M		Commercial	ND	--	--	NO_3	6.2-7.5	Incr.
42	Q2027	UG		Residential	PCE	1-5	Stable	NO_3	9.6-12	Stable
42A	Q2028	M		Residential	ND	--	--	Fe	0.5-0.7	Stable
46	Q2243	UG		Residential	PCE	2-36	Stable	NO_3	6.9-9.6	Stable
47	Q2275	UG	Off-2/83	Residential	PCE	10-120	Incr.	NO_3	7.2-9.3	Incr.
47A	Q2276	M		Residential	ND	--	--	NO_3	3-5	Stable
48	Q2229	UG		Commercial	PCE	10-79	Var.	NO_3	9.2-10.8	Stable
48A	Q2300	M	Off-10/82	Commercial	PCE	19-66	Incr.	NO_3	7.7-8.2	Stable
49	Q2321	UG	Off-12/82	Commercial	PCE	10-180	Incr.	NO_3	7.2-8.4	Stable
49A	Q2343	M		Commercial	PCE	2-13	Stable	NO_3	9.6-12	Incr.
54	Q2442	UG	Off-9/82	Commercial	PCE	53-140	Incr.	--	--	--
54A	Q2443	M		Commercial	ND	--	--	--	--	--
55	Q3034	M		Industrial	PCE	7-11	Stable	NO_3	5.7-6.2	Stable
56	Q2955	M		Commercial	ND	--	--	Fe	0.4-0.5	Stable
59	Q3062	M		Residential	ND	--	--	--	--	Stable
60	Q3083	M		Residential	ND	--	--	Fe	1.1-1.5	Stable

JWSC Well No.	NYSDEC Well No.	Aquifer 1/	Status	Environment	Organic Chemical of Concern: Compound	Organic: Concentration Range 4/	Organic: Trend	Inorganic Chemical of Concern: Compound	Inorganic: Concentration Range 4/	Inorganic: Trend
NASSAU COUNTY										
9	N14	UG		Residential	ND	--	--	NO_3	7-8	Stable
15D	N693	UG		Commercial/ Industrial	PCE	2-5	Stable	NO_3	4.7-9.2	Incr.
15A	N9151	M		Commercial/ Industrial	ND	--	--	NO_3	6-7	Stable
15B	N12	M		Commercial/ Industrial	ND	--	--	--	--	Stable
15C	N13	M		Commercial/ Industrial	PCE	10-19	Stable	--	--	Stable
16	N15	UG	Off-9/78	Commercial/ Residential	PCE	22-380	Incr.	NO_3	5-6	Stable
16A	N1958	L		Commercial/ Residential	ND	--	--	--	--	Stable
20	N17	M		Industrial Landfill	PCE	1-11	Stable	NO_3	4-7	Incr.
25	N2115	UG		Residential	3/	4-8	Stable	Cl	30-44	Incr.
25A	N7482	M		Residential	ND	--	--	--	--	Stable
28	N2414	UG		Residential	PCE	1-135	Incr.	NO_3	6-6.5	Stable
28A	N2413	M		Residential	ND	--	--	Fe	0.3-0.4	Stable
30	N3720	M		Residential	ND	--	--	--	--	Stable
34	N4512	M		Residential	ND	--	--	--	--	Stable
35	N4077	UG		Residential/ Industrial	PCE TCE	7-19 1-37	Stable Stable	Cl	34-60	Incr.
35A	N4298	M		Residential/ Industrial	TCE	17-36	--	--	--	--

JWSC Well No.	NYSDEC Well No.	Aquifer 1/	Status	Environment	Organic Chemical of Concern: Compound	Organic: Concentration Range 4/	Organic: Trend	Inorganic Chemical of Concern: Compound	Inorganic: Concentration Range 4/	Inorganic: Trend
40	N4390	M		Commercial	PCE	9-15	Stable	--	--	Stable
					TCE	3-11	Stable	--	--	Stable
40A	N7445	M		Commercial	PCE	2-17	Stable	--	--	Stable
					TCE	1-12	Stable	--	--	Stable
44	N5155	UG		Commercial	PCE	1-12	Stable	--	--	Stable
44B	N6744	UG		Commercial	PCE	1-23	Stable	NO_3	3.2-6.7	Incr.
44A	N5156	M		Commercial	ND	--	--	--	--	Stable
44C	N6745	M		Commercial	ND	--	--	--	--	Stable
57	N7649	UG		Industrial	TCE	4-30	Incr.	NO_3	8.6-9.6	Incr.
					PCE	1-9	Stable			
57A	N7650	M		Industrial	PCE	8-21	Incr.	--	--	Stable

1/ UG - Upper Glacial Aquifer (Post Jameco)
J - Jameco Aquifer
M - Magothy Aquifer
L - Lloyd Aquifer
2/ Trichlorofluoromethane
3/ 1,2 Dichloroethane, 1,2 Dichloroethylene
4/ Annual average 1975-1982

TABLE 3

JAMAICA WATER SUPPLY COMPANY

WELL CAPACITY SUMMARY

Table 3

JAMAICA WATER SUPPLY COMPANY
WELL CAPACITY SUMMARY

Well No.	Authorized Capacity (mgd)	Authorized Capacity (gpm)	Rated Capacity (gpm)a/	1981 Avg. Daily Pumpage (gpd x 1000)	1981 Load Factor (%)	1981 Production Rate (gpm)	1982 Avg. Daily Pumpage (gpd x 1000)	1982 Load Factor (%)	1982 Production Rate (gpm)
WEST SECTOR - QUEENS COUNTY									
West Sector - Upper Glacial Aquifer									
1	0.216	150	250	138.9	55.2	175	161.4	64.5	174
3	0.432	300	250	597.2	97.6	425	580.6	99.5	405
3A	0.936	650	500	599.7	98.0	425	584.7	85.9	473
4	0.540	375	350	224.3	52.3	298	407.3	94.6	299
8	0.504	350	350	309.8	66.8	322	212.6	42.8	345
22	0.540	375	250	178.3	59.8	207	297.8	99.5	208
31	1.310	910	900	1,386.5	99.0	973	902.5	80.9	775
32	1.440	1000	900	1,086.3	83.7	901	1,296.2	99.8	902
41	0.936	650	500	180.8	16.4	766	234.5	21.3	765
43	1.368	950	900	1,295.8	99.7	903	1,297.8	99.8	903
45	1.512	1050	1000	1,399.4	99.9	973	1,399.5	99.9	973
Totals	9.734	6760	6150	7,397.0			7,374.9		
West Sector - Jameco Aquifer									
11	1.987	1380	1380	1,295.8	99.8	902	1,281.4	99.8	892
14	1.584	1100	1200	698.8	98.5	486	587.1	83.7	487
Totals	3.571	2480	2580	1,994.6			1,868.5		
West Sector - Magothy Aquifer									
17A	0.763	530	500	967.6	96.6	696	405.5	75.9	371 ?
43A	1.872	1300	500	1,297.5	99.9	902	1,100.3	85.3	896
Totals	2.635	1830	1000	2,265.1			1,505.8		

Well No.	Authorized Capacity (mgd)	Authorized Capacity (gpm)	Rated Capacity (gpm)a/	1981 Avg. Daily Pumpage (gpd x 1000)	1981 Load Factor (%)	1981 Production Rate (gpm)	1982 Avg. Daily Pumpage (gpd x 1000)	1982 Load Factor (%)	1982 Production Rate (gpm)
West Sector - Lloyd Aquifer									
8A	1.584	1100	1000	1,302.4	91.3	991	1,395.9	99.8	971
17	1.872	1300	1000	1,489.0	99.3	1041	1,405.5	94.3	1035
Totals	3.456	2400	2000	2,791.4			2,801.4		
TOTAL/WEST SECTOR									
	19.396	13470	11730	14,448.1			13,550.6		

NORTH SECTOR - QUEENS COUNTY

Well No.	Authorized Capacity (mgd)	Authorized Capacity (gpm)	Rated Capacity (gpm)a/	1981 Avg. Daily Pumpage (gpd x 1000)	1981 Load Factor (%)	1981 Production Rate (gpm)	1982 Avg. Daily Pumpage (gpd x 1000)	1982 Load Factor (%)	1982 Production Rate (gpm)
North Sector - Upper Glacial Aquifer									
19	0.259	180	0	0	0	0	0	0	0
21	0.377	262	0	0	0	0	0	0	0
27	1.476	1025	1000	1,211.3	89.8	937	1,376.7	99.9	957
37	0.720	500	750	495.8	45.2	762	521.1	51.9	697
50	1.296	900	900	949.8	100	660	944.7	99.8	657
52	0.936	650	600	624.1	89.2	486	699.5	99.9	486
53	1.440	1000	700	849.5	99.8	591	941.4	99.7	656
Totals	6.504	4517	3950	4,130.5			4,483.4		
North Sector - Magothy Aquifer									
18	0.648	450	350	243.5	48.7	347	479.2	95.9	346
21A	1.728	1200	1200	1333.4	98.0	945	615.6	41.1	1040
50A	1.440	1000	1000	1349.8	99.9	938	1314.5	97.5	936
51	1.440	1000	1000	1399.1	99.6	975	1398.6	99.8	973
53A	1.440	1000	1000	799.4	99.8	556	1069.0	97.8	759
58	1.152	800	850	1199.7	99.9	834	1064.9	88.5	836
Totals	7.848	5450	5400	6324.9			5941.8		

Well No.	Authorized Capacity (mgd)	Authorized Capacity (gpm)	Rated Capacity (gpm)a/	1981 Avg. Daily Pumpage (gpd x 1000)	1981 Load Factor (%)	1981 Production Rate (gpm)	1982 Avg. Daily Pumpage (gpd x 1000)	1982 Load Factor (%)	1982 Production Rate (gpm)
North Sector - Lloyd Aquifer									
18A	1.728	1200	1000	759.1	58.3	904	1278.1	90.1	985
TOTALS/NORTH SECTOR									
	16.080	11167	10350	11,214.5			11,703.3		

EAST-CENTRAL SECTOR - QUEENS COUNTY

Well No.	Authorized Capacity (mgd)	Authorized Capacity (gpm)	Rated Capacity (gpm)a/	1981 Avg. Daily Pumpage (gpd x 1000)	1981 Load Factor (%)	1981 Production Rate (gpm)	1982 Avg. Daily Pumpage (gpd x 1000)	1982 Load Factor (%)	1982 Production Rate (gpm)
East-Central Sector - Upper Glacial Aquifer									
5	0.288	200	0	0	0	0	0	0	0
6	0.144	100	500	3201.3 b/	14.9	b/	230.4	32.4	494
6A	1.008	700	700	b/	25.1	b/	655.1	55.4	821
6B	0.288	200	900	b/	0	0	0	0.4	0
6D	0.216	150	550	b/	0	0	0	0	0
7	0.530	368	150	57.5	29.1	137	72.5	29.4	171
7A	0.150	104	150	54.5	27.2	139	68.6	32.8	145
10	0.864	600	700	323.5	36.0	624	471.8	52.4	625
13	0.288	200	0	0	0	0	0	0	0
23	0.720	500	300	20.5	3.9	365	125.5	24.6	354
24	0.340	236	40		0.3	c/	0	0	0
24A	0.360	250	225	318.1	15.3	c/	230.5	64.0	250
24B	0.650	451	500		21.2	c/	334.0	51.5	450
24C	0.400	278	250		31.9	c/	255.3	63.7	278
26	0.648	450	400	384.9	76.3	350	378.1	75.5	348
29	0.321	223	500	0	1.4	0	0	0	0
33	1.008	700	500	116.9	29.2	278	0	0	0
38	1.584	1100	900	1299.7	100	903	1297.3	99.9	902
39	0.749	520	500	700.0	99.9	487	699.5	99.9	486

.1 .o.	Authorized Capacity (mgd)	Authorized Capacity (gpm)	Rated Capacity (gpm)a/	1981 Avg. Daily Pumpage (gpd x 1000)	1981 Load Factor (%)	1981 Production Rate (gpm)	1982 Avg. Daily Pumpage (gpd x 1000)	1982 Load Factor (%)	1982 Production Rate (gpm)
42	0.778	540	350	108.4	35.5	212	122.2	38.0	223
46	1.584	1100	350	117.2	14.6	557	366.6	54.7	465
47	1.296	900	1000	315.6	22.1	992	405.5	27.2	1035
48	1.872	1300	1400	968.2	57.0	1180	698.4	41.0	1183
49	1.872	1300	1200	1376.4	80.9	1181	1695.1	99.6	1182
54	1.728	1200	1000	188.4	12.2	1072	255.1	17.2	1030
Totals	19.686	13670	13065	9551.1			8361.5		

East Central Sector - Magothy Aquifer

5A	2.448	1700	1500	2151.0	99.9	1495	2127.4	99.9	1479
7B	1.361	945	950	1193.1	97.9	846	893.2	77.7	798
10A	2.592	1800	1600	2192.6	99.7	1527	2174.5	99.6	1516
13A	1.440	1000	1000	1648.4	99.9	1146	1645.5	99.9	1144
23A	2.160	1500	1600	823.8	36.0	1589	1937.8	84.7	1589
26A	2.304	1600	1600	1356.9	79.4	1187	1689.9	99.5	1179
29A	2.304	1600	1600	268.7	12.0	1555	383.8	17.5	1523
36	2.304	1600	1600	1733.4	75.8	1588	1840.0	80.5	1587
38A	2.592	1800	1600	2195.8	99.8	1528	2192.6	99.6	1529
39A	2.304	1600	1600	2199.1	99.8	1530	2197.0	99.9	1527
42A	2.448	1700	1600	1958.3	89.0	1528	2243.6	88.2	1767
47A	2.304	1600	1600	1182.7	65.7	1250	2069.0	97.1	1480
48A	2.592	1800	1600	1278.9	58.1	1529	542.7	24.7	1526
49A	2.304	1600	1600	644.1	37.5	1193	849.9	48.8	1209
54A	1.728	1200	1200	766.0	48.3	1101	1324.1	82.8	1111
55	2.016	1400	1300	1819.4	95.7	1320	1897.5	99.9	1319
56	2.016	1400	1300	990.4	43.3	1588	1507.9	67.0	1563
59	2.016	1400	1300	1716.1	90.2	1321	1742.7	91.8	1318
60	2.016	1400	1300	749.0	38.9	1227	258.1	13.5	1328
Totals	41.249	28645	27450	26,867.7			29,517.2		

Well No.	Authorized Capacity (mgd)	Authorized Capacity (gpm)	Rated Capacity (gpm)a/	1981 Avg. Daily Pumpage (gpd x 1000)	1981 Load Factor (%)	1981 Production Rate (gpm)	1982 Avg. Daily Pumpage (gpd x 1000)	1982 Load Factor (%)	1982 Production Rate (gpm)
East-Central Sector - Lloyd Aquifer									
6C	2.592	1800	1800	b/	99.8		2935.3	99.5	2049
TOTALS/EAST-CENTRAL SECTOR									
	63.527	44115	42315	36,418.8			40,814.0		
TOTALS/QUEENS COUNTY									
	99.003	68752	64395	62,081.4			66,067.9		

NASSAU COUNTY

Well No.	Authorized Capacity (mgd)	Authorized Capacity (gpm)	Rated Capacity (gpm)a/	1981 Avg. Daily Pumpage (gpd x 1000)	1981 Load Factor (%)	1981 Production Rate (gpm)	1982 Avg. Daily Pumpage (gpd x 1000)	1982 Load Factor (%)	1982 Production Rate (gpm)
Nassau - Upper Glacial Aquifer									
9	0.864	600	700	21.9	1.8	845	82.5	5.5	1042
15D	2.500	1736	1600	213.4	10.2	1453	467.7	22.9	1418
16	0.288	200	100-0	0	0	0	0	0	0
25	1.728	1200	1200	73.6	8.1	631	109.0	12.9	587
28	1.728	1200	1000	130.4	8.8	1029	264.4	18.4	998
35	0.720	500	350	124.1	24.7	349	71.9	13.5	365
44	0.864	600	350	58.3	11.3	358	34.0	6.5	363
44B	1.008	700	700	186.3	17.8	727	51.5	5.0	715
Totals	9.700	6736	6000	808.0			1081.0		

Well No.	Authorized Capacity (mgd)	(gpm)	Rated Capacity (gpm)a/	1981 Avg. Daily Pumpage (gpd x 1000)	1981 Load Factor (%)	1981 Production Rate (gpm)	1982 Avg. Daily Pumpage (gpd x 1000)	1982 Load Factor (%)	1982 Production Rate (gpm)
Nassau - Magothy Aquifer									
15A	1.584	1100	1000	1,344.1	72.1	d/	1398.1	99.3	978
15C	1.872	1300	400		64.7	d/	181.6	45.2	279
15B	2.016	1400	1000	613.9	43.6	978	538.1	37.8	959
20	1.728	1200	500	614.5	86.7	492	687.7	97.3	491
25A	2.592	1800	1600	691.5	40.7	1180	791.7	37.4	1336
28A	1.296	900	900	336.7	30.0	779	320.0	25.0	889
30	1.728	1200	1100	435.6	26.7	1133	437.5	27.5	1105
34	2.448	1700	1500	1799.4	99.9	1251	1793.4	99.4	1253
35A	2.592	1800	1600	1323.2	53.9	1705.2	1705.2	71.0	1668
40	2.016	1400	1400	1596.4	88.8	1248	1777.3	98.7	1250
40A	1.728	1200	800	280.0	32.9	591	75.1	10.5	497
44A	2.304	1600	1600	1201.0	55.1	1541	1453.7	66.3	1523
44C	2.304	1600	1600	1294.2	59.2	1521	505.8	23.1	1521
57	1.728	1200	1100	752.0	52.9	987	538.1	55.5	673
57A	1.728	1200	1300	1514.2	94.4	1114	1169.9	72.9	1114
Totals	29.664	20600	17400	13,796.7			13,373.2		
Nassau - Lloyd Aquifer									
16A	1.606	1115	1200	1024.6	57.5	1237	1691.8	99.4	1182
TOTALS/NASSAU COUNTY									
	40.970	28451	24600	15,629.3			16,146.0		
GRAND TOTALS									
	139.973	97203	88995	77,710.7			82,213.9		

a/ Based on latest estimates by JWSC Engineering Department.

b/ Reported as total of all 5 wells at this station, subtotals include 6C as a UG well.

c/ Pumpage distribution among 4 wells at this station uncertain.

d/ Pumpage distribution between Wells 15A and 15C uncertain.

TABLE 4

JAMAICA WATER SUPPLY COMPANY

ASSESSMENT OF VULNERABILITY
OF WELLS TO ORGANIC CONTAMINATION

Table 4

JAMAICA WATER SUPPLY COMPANY

ASSESSMENT OF VULNERABILITY
OF WELLS TO ORGANIC CONTAMINATION

Well No.	Organics Quality Assessment Classification					Comments [1/]
	I (mgd)	II (mgd)	III (mgd)	IV (mgd)	V (mgd)	
West Sector - Queens County						
1			0.360			Chlorides increasing
3		0.360				Nitrates 10+
3A		0.720				Nitrates high
4			0.504			Nitrates 10+
8					0.504	Closed 9/82, TCE 110, PCE 29, Iron treatment
8A	1.440					Iron treatment
11	1.987					Chlorides increasing
14	1.728					Chlorides increasing
17	1.440					Iron treatment
17A	0.720					Iron treatment, chlorides increasing
22			0.360			Chlorides increasing
31					1.296 [2/]	Iron treatment, TCTFM
32			1.296			Nitrates 8+
41					0.720	Closed 9/81, TCE 220, PCE 18, chlorides increasing
43			1.296			
43A	0.720					
45			1.440			Nitrates 8+
Sector Totals	8.035	1.080	5.256	0	2.520	16.891 (11,730 gpm)
(Wells)	(6)	(2)	(6)	(0)	(3)	(17)

Well No.	Organics Quality Assessment Classification I (mgd)	II (mgd)	III (mgd)	IV (mgd)	V (mgd)	Comments 1/
North Sector - Queens County						
18		0.504				
18A	1.440					
19	0					
21	0					Chlorides increasing
21A	1.728					
27	1.440					
37			1.080			
50		1.296				Chlorides increasing
50A	1.440					
51		1.440				Chlorides increasing, Nitrates 7
52	0.864					
53			1.008			
53A	1.440					
58	1.224					
Sector Totals (Wells)	9.576 (9)	3.240 (3)	2.088 (2)	0 (0)	0 (0)	14.904 (10,350 gpm) (14)
East - Central Sector - Queens County						
5			0			
5A		2.160				
6					0.720	Closed 9/81, PCE 260, Nitrates 6
6A				1.008		High Iron +9
6B				1.296		High Iron - Closed
6C	2.592					
6D					0.792	Closed 10/79, PCE 130, Nitrates 7+
7		0.216				Nitrates 8+
7A		0.216				Nitrates 4-8
7B		1.368				Nitrates 5+

Well No.	Organics Quality Assessment Classification					Comments 1/
	I	II	III	IV	V	
10		1.008				
10A		2.304				
13		0				
13A		1.440				
23		0.432				
23A	2.304					
24					0.058	Closed 10/75
24A					0.324	Closed 12/82, PCE 149
24B					0.720	Closed 12/82, PCE 117
24C				0.360		
26		0.576				
26A		2.304				
29					0.720	Closed 9/75, PCE 5600
29A					2.304	Closed 12/82, PCE 250, TCE 23
33					0.720	Closed 9/81, Xylene 117
36	2.304					
38		1.296				
38A		2.304				
39		0.720				Nitrates 7-8+
39A	2.304					Nitrates 7
42		0.504				Nitrates ±12
42A	2.304					
46		0.504				Nitrates 7-9+
47					1.440	Closed 2/83, PCE 120 Nitrates ±9
47A		2.304				
48				2.304		Nitrates ±10, PCE variable
48A					2.160	Closed 10/82, PCE 66, Nitrates ±8
49					1.728	Closed 12/31/82, PCE 180 Nitrates ±8
49A			2.304			Nitrates 9-10+

Well No.	Organics Quality Assessment Classification I	II	III	IV	V	Comments 1/
54					1.440	Closed 9/16/82, PCE 120
54A		1.728				
55		1.872				
56		1.872				
59	1.872					
60	1.872					High iron
Sector Totals	15.552	25.128	2.304	4.968	13.126	61.078 (42,415 gpm)
(Wells)	(7)	(20)	(2)	(4)	(12)	(45)
Queens County Totals	33.163	29.448	9.648	4.968	15.646	92.873 (64,495 gpm)
(Wells)	(22)	(25)	(10)	(4)	(15)	(76)
Nassau County						
9		1.008				Nitrates ±7
15A		1.440				
15B		1.440				
15C			0.576			
15D			2.304			
16					0.072	Closed 9/78, PCE 310
16A	1.728					
20			0.720			Nitrate 7+
25		1.728				
25A	2.304					
28				1.440		Previous TCE, low usage
28A	1.296					
30	1.584					
34	2.160					
35			0.504			TCE 2-14
35A			2.304			TCE 25
40			2.016			PCE ±10, TCE 6-8
40A			1.152			

Well No.	Organics Quality Assessment Classification					Comments 1/
	I	II	III	IV	V	
44		0.504				
44A	2.304					
44B		1.008				
44C	2.304					
57			1.584			Nitrates ±9, TCE ±30, PCE 9
57A			1.872			TCE ±20
Nassau Totals (Wells)	13.680 (7)	7.128 (6)	13.032 (9)	1.440 (1)	0.072 (1)	35.352 (24,550 gpm) (24)
GRAND TOTALS (Wells)	46.843 (29)	36.576 (31)	22.680 (19)	6.408 (5)	15.718 (16)	128.225 (89,045 gpm) (100)

1/ Concentrations for inorganic constitutents reported in mg/l; organic chemicals in ug/l.

2/ Not presently closed but data indicate organic contamination above New York guideline before treatment.

APPENDIX I

EXPERIENCES OF OTHER UTILITIES

WITH VOC CONTAMINATION

APPENDIX I

EXPERIENCES OF OTHER UTILITIES WITH VOC CONTAMINATION

I. Long Island: Nassau County

1. Garden City Park Water District
2. Village of Glen Cove
3. Hicksville Water District
4. Bethpage Water District
5. Non-potable wells

II.. Long Island: Suffolk County

1. East Farmingdale Water District
2. South Huntington Water District
    - A. Station 1
    - B. Station 3
3. Brentwood Water District
4. Suffolk County Water Authority
    - A. Bellrose Ave. Station. East Northport
    - B. Oval Drive Station, Central Islip
    - C. Albany Ave. Station, No. Amityville
    - D. East Forks Rd. Station, No. Bay Shore
    - E. Locust Ave. Station, Bohemia
    - F. Samuel St. Station, Ronkonkoma
    - G. Meade Drive Station, Centerport

EXPERIENCES OF OTHER UTILITIES WITH VOC CONTAMINATION

I. Long Island: Nassau County

1. Garden City Park Water District

The experiences of this water district with closings of Well Nos. 4 and 5 due to the presence of approximately 60 ug/l of tetrachloroethylene is of special significance to the JWSC since these wells are located on the east side of Denton Avenue, several hundred feet north of Evergreen Avenue. Both wells are screened in the Magothy Formation more than 400 feet deep and although only 200 feet apart, one well contains 14 mg/l of nitrate-nitrogen and the other only 6-7 mg/l. In addition, Well No. 6, screened in the Magothy Formation and located about 1200 feet to the northeast now contains 82 ug/l of PCE and was removed from service in 1983.

A study recently conducted for the Nassau County Health Department by ERM-Northeast included the installation of several sets of observation wells along the eastern and southern borders of the now closed landfill north of Evergreen, and west of Denton Avenue. Their conclusions include that ground-water flow is slightly south of due west, and that even though some of the observation wells were drilled through and under old compacted refuse, no organic chemicals, either VOCs or XBTs, were detected, and that the landfill materials were not responsible for the closings of these wells.

Well No. 20 in the JWSC system has only intermittently demonstrated very low concentrations of PCE (less than 10 ug/l) and nitrate-nitrogen has averaged 7 mg/l even though this well has been operated near 100 percent load for the past several years.

The landfill has been closed for many years, and water quality continues to remain satisfactory, so it does not appear that this well is under serious immediate threat, but it should be monitored closely in view of the experiences in other Magothy wells upgradient to the east and northeast.

2. Village of Glen Cove

In the late 1970's, five wells in the Magothy and Upper Glacial Formations were contaminated with PCE and TCE and removed from service. A federally funded (EPA) study was conducted by NKRE Associates pilot testing the feasibility of aeration, GAC and resin treatments. Two of the wells have improved sufficiently after being pumped to waste for significant periods to be returned to service, while three new wells have been drilled at another location to replace the lost capacity. Magothy Well No. 22 originally contained 300 ug/l of TCE and 150 ug/l PCE. After several months of operation of the pilot plant, the on-site gas chromatograph detected cis-1,2 dichloroethylene, which proved most difficult to reduce. A Glacial well on the same site contained 100 ug/l of PCE only. No treatment unit is presently contemplated at this location.

3. Hicksville Water District Well Nos. 1-5

This well, 500 feet in depth, screened in the Magothy Formation has been closed for 4 years. The last sampling indicated 43 ug/l TCE, 2 of PCE, 33 of 1,1,1-trichloroethane, 30 of cis & trans 1,2 dichloroethylene, 14 of 1,1 dichloroethane, and 8 ug/l of 1,1 dichloroethylene. Recent pilot-plant aeration studies were successfully carried out and Hicksville has authorized its consulting engineers to provide a design of a full scale treatment unit.

4. The Bethpage Water District

Well No. 6-1 is screened in the Magothy Formation, contains 63 ug/l TCE at last sampling. While slightly improved, this well remains closed with no plans known for treatment.

5. Non-potable Wells

The contamination by VOCs discovered in an air-conditioning well for an office building near Roosevelt Field has not been resolved. Negotiations with the NYSDEC continue over the recharge issue. The discovery of very large concentrations of solvents in the ground water (more than 100,000 ug/l) in the Mitchell Field area has not yet affected the wells of the Uniondale Water District which are calculated by NCHD to be downgradient.

II. Long Island: Suffolk County

1. East Farmingdale Water District

Well No. 2-1 (S20041) is 268 feet and screened in the Upper Glacial Aquifer. It has been out of service since late 1977 when more than 100 ug/l of 1,1,1 trichloroethane and 20 ug/l of TCE was detected. Annual pumping to waste has not indicated any improvement in this water, and it remains out of service, with no known plans for treatment.

2. South Huntington Water District

A. Station No. 1 is located near the ground water divide above the "buried glacial valley" with two wells screened in the Upper Glacial Aquifer, 271 feet and 602 feet deep. The shallower well was closed in December 1978 with more than 300 ug/l of PCE and 12 ug/l TCE. At that time the deeper well was free of contamination. The deeper well was then operated virtually continuously, and within a year PCE concentrations in 4 samplings increased from zero to 54 to 120 to 160 ug/l when it was closed in January 1980 and has remained closed.

In December 1982 the 271 foot well was pumped to waste, and aerated inside a recharge basin. The untreated water now contains 230 ug/l PCE, 52 of cis-1,2 dichloroethylene, 12 of 1,1,1 trichloroethane, and 5 of 1,1,2 trichloroethane. Puddled water in the basin contained 75-100 ug/l PCE, and subsequently after a new spray nozzle was installed, standing water only contained 27 ug/l. No improvement has yet been detected in the well water.

B. Station No. 3. Well No. 3-1 at this site is a 150 foot deep well screened in the Upper Glacial material. The well was drilled with satisfactory chemical quality, but not used for several years due to mechanical problems. The first sample in service was over the limit of 50 ug/l for PCE, plus 20± of cis-1,2 dichloroethylene, and was closed in the summer of 1982. In October 1982, the consulting engineer for this District recommended aerating the ground water and recharging at the site because: the concentrations were relatively moderate, the driller's log indicated no aquicludes especially in the unsaturated zone, the well was relatively shallow, and there was already on the site a recharge basin large enough to handle the full production of the well. Within 5 or 6 weeks the water produced by the well had improved from 50 to 20 ug/l PCE, and from 22 to 5 ug/l of cis-1,2 dichloroethylene. The District now routinely operates this well into the distribution system and the quality of the water produced has remained at similar levels for PCE.

3. Brentwood Water District

Well No 1-1 is an Upper Glacial Aquifer well 130 feet deep at their main pumping station, south of the Long Island Railroad in Brentwood. In 1978 this well was closed with the detection of more than 100 ug/l of benzene and less than 5 ug/l of toluene. There are or were several gasoline filling stations and a large metal treating plant upgradient of this site. The New York State Department of Transportation then investigated, by drilling more than 12 observation wells above the northerly boundary of the property. No "floating" product was discovered in any well, and no leaks were detected in any gasoline tank tested by the Kent-Moore test, although more than 400 ug/l of benzene was detected in one observation well closest to and upgradient of Production Well 1-1. A report was issued, citing these results and disclaiming any liability under the State Superfund Act.

4. Suffolk County Water Authority

The SCWA presently owns 15 wells out of 402 which are out of service or restricted because of VOCs. Only one well (Lincoln Avenue Station, Lakeland, Well No. 1) which was previously closed, improved sufficiently to return to routine operation. Several wells, such as those at Oval Drive, Central Islip and Locust Avenue, Bohemia, contain concentrations which are related to total withdrawals, and are operated sporadically with frequent monitoring, closing and reopening with changes in concentration. The remaining wells have remained or increased in concentration since first closed.

A. Bellerose Avenue Station, East Northport. This well is a new well drilled in Glacial material to a depth of 594 feet. Samples analyzed during development of the well indicated 25 ug/l of PCE. After the well was accepted, and after an additional year for the construction of the well vault, chemical building, yard piping, etc., a sample collected within 48 hours of operation exceeded the limit for PCE, rising to 100 ug/l.

The well was pumped to waste and after several months at 200 ug/l a consulting engineering firm was engaged to utilize its pilot air-stripping column. The results indicated 85-90 percent removal and mass-transfer coefficients calculated that predicated 95 percent removal from 1100 gpm with a 6-foot diameter column 20 feet high packed with Raschig rings. This project was advertised for bid requiring reduction of PCE from 300 to 10 ug/l. The bids were not opened when it was discovered that the PCE concentration had since exceeded 400 ug/l. The project is to be redesigned and resubmitted for bidding.

B. Oval Drive Well Field, Central Islip. This site contains three Glacial wells and one Magothy well. Two Glacial wells closest to Oval Drive were closed after excessive concentrations of 1,1,1 trichloroethane was discovered. Directly across Oval Drive was located an industry which repackaged a product used for opening drains and cesspools, whose major ingredient was 1,1,1-trichloroethane. This industry subsequently relocated out of the state. After the successful testing and technology transfer from the Bellerose Avenue project, the SCWA purchased its own portable pilot plant for air-stripping, and it was erected at Oval Drive. After several years of shut down, considerable pumpage was required to obtain concentrations exceeding the guideline. The results confirmed that greater air-to-water volume/volume ratios were required to strip 1,1,1-trichloroethane than PCE. The treatment unit has not been designed. Operation of this station is severely restricted to avoid contamination of the third Glacial well, and to avoid contaminating the Magothy well at this site as well.

C. Albany Avenue, North Amityville. This well field contains 3 Upper Glacial wells 84 feet to 85 feet deep, all of which were closed in 1978 after concentrations as high as 800 ug/l were detected. This well field is downgradient of industrial activity south of Republic Airfield. They have now been permanently disconnected from the system and only the Magothy wells at this site are operated.

D. East Forks Road Station, North Bay Shore. Two Upper Glacial wells at this site have been closed with the detection of more than 100 ug/l of 1,1,1-trichloroethane. These wells are in a residential area; no source of contamination has been identified, and they remain closed.

E. Locust Avenue Station, Bohemia. This site contains three Glacial wells, 140-149 feet deep. The site is downgradient of considerable industrial activity in an industrial park south of MacArthur Airport. The concentrations of TCE present varies well by well with changes in pumping schedules. The first few weeks of operation after a month or two of non-use generally produce water of satisfactory quality. During the summers of 1981 and 1982 part of the production capacity was recovered by utilizing the wells with almost daily sampling and analysis, and resting the wells for several weeks when the concentrations approached 50 ug/l. The wells at this site are to be tested with the pilot air-stripping column during 1983.

F. Samuel Street Station, Ronkonkoma. This site contains three Glacial wells and one Magothy well. The two shallower Upper Glacial wells (160' and 178") contain a mixture of 1,1,1-trichloroethane, TCE and PCE with greater concentrations of the more difficult to treat 1,1,1 TCEA and TCE. Operations at this site have been severely restricted to avoid contaminating the 373 feet deep glacial aquifer well or the deeper Magothy well. The location is subject to vandalism and pilot treatment testing has not been yet attempted.

G. Meade Drive, Centerport. Two wells 145 feet and 185 feet deep and screened in Upper Glacial aquifer contain 200-300 ug/l of TCE. This site is located in a prosperous residential neighborhood with no recognizable source of contamination for thousands of feet upgradient (south). The site is on a steep hillside, and pilot treatment testing has not yet been scheduled. A new deep well was recently completed to replace lost capacity.

APPENDIX II

JAMAICA WATER SUPPLY COMPANY

CHRONOLOGICAL FILE

VOLATILE ORGANIC CHEMICAL ANALYSES

APPENDIX II

JAMAICA WATER SUPPLY COMPANY

CHRONOLOGICAL FILE
VOLATILE ORGANIC CHEMICAL ANALYSES

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)
QUEENS COUNTY				
Well 1				
09/13/79 (CH)	n	n	n	n
08/01/80 (SH)	n	n	n	n
08/21/80 (CH)	n	n	n	n
09/08/81 (CH)	n	n	n	n
Well 3				
10/03/79 (CH)	n	n	n	n
07/15/80 (SH)	n	n	n	n
08/26/81 (CH)	n	n	n	n
09/08/82 (CH)	n	n	n	n
Well 3A				
10/03/79 (CH)	n	n	n	n
07/15/80 (SH)	n	n	n	n
08/26/81 (CH)	n	n	n	n
09/08/82 (CH)	n	n	n	n
Well 4				
10/01/79 (CH)	n	n	n	n
07/15/80 (SH)	13	n	n	n
08/26/81 (CH)	32	n	n	n
09/18/81 (CH)	n	n	n	n
09/25/81 (CH)	7.6	n	n	n
09/28/82 (CH)	25	n	n	n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
Well 5A					
09/27/79 (CH)	8	n	n		n
08/19/80 (SH)	6	n	n		n
09/08/81 (CH)	5	n	n	(19)	5
09/14/82 (CH)	5.4	n	n		n
Well 6					
08/21 80 (SH)	390	n	n		n
09/16/80 (SH)	330	n	n		n
04/16/81 20 min	1	n	n		n
04/22/81	2	n	n		n
08/12/81	350	1	n		n
09/02/81 (CH)	135	n	n		n
04/16/82	260	1	n		n
05/13/82	130	n	n		n
08/26/82	250	n	n	(5)	2
09/15/82	260	1	n	(5)	8
Well 6A					
08/23/79 (CH)	3	n	n		n
06/24/80 (SH)	5	n	n		n
09/08/81 (CH)	4.2	n	n		n
05/13/82	n	n	n		n
07/27/82	n	n	n		n
08/26/82	2	1	n	(5)	1
				(12)	1
Well 6C					
09/16/79 (CH)	n	n	n		n
06/11/80 (SH)	n	n	n		n
09/02/81 (CH)	1.2	n	n		n
01/20/82	n	n	n		n
03/04/82	n	n	n		n
05/13/82	n	n	n		n
08/26/82	n	n	n		n
09/08/82 (CH)	n	n	n		n
01/27/83	n	n	n		n
01/27/83 (CH)	n	n	n		n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
Well 6D					
10/25/79 16 hrs	155	2	n	(5)	5
10/31/79 1½ hrs	170	2	n	(5)	5
				(6)	4
11/15/79	167	2	n	(5)	5
04/10/80 3 hrs	120	1	n		n
04/10/80 7 hrs	120	2	n		n
04/24/80	160	2	n	(5)	1
05/08/80 2 hrs	200	2	n	(5)	2
06/23/80 (NY)	124	n	3	(2)	5
06/27/80 (NY)	13	4	193	(1)	18
09/11/80 3 hrs	65	2	n	(5)	3
09/12/80	159	3	n	(5)	9
12/02/80	240	3	n	(5)	8
				(19)	1
01/02/81	300	n	n	(3)	7
				(4)	8
				(8)	4
02/03/81	220	n	n		n
03/05/81	220	2	n	(3)	1
				(5)	4
04/22/81	190	1	n	(5)	2
08/12/81	150	1	n	(5)	1
01/12/82	87	1	n		n
03/04/82	200	n	n		n
04/16/82	130	1	n		n
Well 7					
06/17/80 (SH)	2	n	n		n
06/19/81 (CH)	n	n	n		n
07/20/82 (CH)	n	n	n		n
Well 7A					
06/17/80 (SH)	2	n	n		n
08/19/81 (CH)	n	n	n		n
07/20/82 (CH)	n	n	n		n
Well 7B					
09/27/79 (CH)	2	n	n		n
06/17/80 (SH)	2	n	n		n
08/19/81 (CH)	1.1	n	n		n
07/10/82 (CH)	0.4	n	n		n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
.1 8					
10/04/79 (CH)	12	33	4	(6)	4
				(10)	12
12/12/79 (CH)	12	31	4	(6)	4
				(10)	12
07/22/80 (SH)	16	38	5	(6)	4
				(10)	12
09/09/80 (SH)	13	32	4	(6)	4
				(10)	11
08/26/81 (CH)	22	79	6.7	(6)	2.7
				(10)	8.5
09/02/81	29	86	6	(2)	2
				(3)	1
				(5)	2
				(6)	3
				(10)	11
				(23)	3
10/23/81	n	n	n	(6)	1
04/16/82	6	17	n	(6)	2
				(10)	3
05/03/82	14	40	5	(2)	1
				(5)	1
				(6)	2
				(10)	7
				(23)	2
05/13/82	15	37	5	(6)	2
				(10)	7
				(24)	1
08/26/82	32	110	n	(2)	1
				(3)	1
				(4)	2
				(5)	3
				(23)	3
09/15/82	29	110	n	(3)	1
				(5)	1
				(6)	3
				(10)	8
				(23)	2
01/27/83 5 min	1	1	n	(6)	5
				(11)	2
				(17)	1
01/27/83 1 hr	1	n	n	(6)	2
				(17)	1
01/27/83 2 hrs	1	1	n	(6)	1
				(11)	1
				(17)	1
01/27/83	1	1	n	(6)	1
				(11)	1

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
				(17)	1
02/11/83	5	n	n		n
04/25/83	2	3	n	(6)	1
				(23)	1
Well 8A					
10/04/79 (CH)	n	n	n		n
08/21/80 (SH)	n	n	n		n
08/26/81 (CH)	n	n	n		n
08/10/82 (CH)	n	n	n		n
01/27/83	n	n	n	(6)	2
				(11)	3
				(17)	2
Well 10					
10/25/79 (CH)	n	n	n		n
08/19/81 (CH)	n	n	n		n
Well 10A					
10/17/79 (CH)	n	n	n		n
08/19/80 (SH)	n	n	n		n
08/14/81 (CH)	n	n	n		n
08/10/82 (CH)	n	n	n		n
Well 11					
10/10/79 (CH)	n	n	n		n
08/26/80 (SH)	n	n	n		n
09/11/81 (CH)	2.9	n	n		n
09/08/82 (CH)	n	n	n		n
03/22/83	n	n	n	(19)	1
Well 13					
07/24/80 (SH)	n	n	n		n
Well 13A					
10/11/79 (CH)	5	n	n		n
08/19/80 (SH)	4	n	n		n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)		OTHERS (ug/l)
09/11/81 (CH)	8.24	n	n		n
09/14/82 (CH)	2.34	n	n		n
Well 14					
10/10/79 (CH)	n	n	n		n
08/26/80 (SH)	n	n	n		n
09/11/81 (CH)	2.6	n	n		n
09/08/82 (CH)	n	n	n		n
03/22/83	n	n	n	(11)	1
				(17)	1
Well 17					
09/06/79 (CH)	n	n	n		n
06/12/80 (SH)	n	n	n		n
08/21/81 (CH)	n	n	n		n
01/27/83	n	n	n		n
02/23/83 (CH)	n	n	n		n
Well 17A					
09/06/79 (CH)	n	n	n		n
06/12/80 (SH)	n	n	n		n
08/26/81 (CH)	n	n	n		n
01/27/83	n	n	n		n
02/23/83 (CH)	n	n	n		n
Well 18					
09/13/79 (CH)	n	n	n		n
06/24/80 (SH)	n	n	n		n
08/17/82 (CH)	n	n	n		n
Well 18A					
09/13/79 (CH)	n	n	n		n
06/24/80 (SH)	n	n	n		n
08/17/82 (CH)	n	n	n		n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
Well 21					
)8/23/79 (CH)	n	n	n		n
08/07/80 (SH)	n	n	n		n
09/16/81 (CH)	n	n	n		n
Well 21A					
10/11/79 (CH)	n	n	n		n
08/07/80 (SH)	n	n	n		n
09/16/81 (CH)	1.5	n	n	(6)	1
				(19)	1.6
				(25)	4.2
09/08/82 (CH)	1	n	n		n
Well 22					
10/18/79 (CH)	9	n	n		n
08/26/80 (SH)	10	n	n		n
09/08/81 (CH)	8.1	0.6	n		n
09/08/82 (CH)	33.6	n	n		n
'0/06/82 (CH)	15.4	n	n		n
Well 23					
10/31/79 (CH)	n	n	n		n
09/02/80 (SH)	n	n	n		n
08/25/81 (CH)	0.2	n	n		n
07/27/82 (CH)	n	n	n		n
Well 23A					
10/17/79 (CH)	n	n	n		n
09/02/80 (SH)	n	n	n		n
09/25/81 (CH)	0.2	n	n		n
07/22/82 (CH)	n	n	n	(25)	0.7?
Well 24A					
10/18/79 (CH)	441	n	2		n
04/10/80 ½ hr	3	n	n		n
04/24/80	2	n	n		n
05/08/80 ½ hr	6	1	n		n
)6/11/80 (SH)	16	n	n		n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)
07/03/80 (SH)	23	n	n	n
08/14/80 (SH)	70	n	n	n
09/09/80 (SH)	97	n	n	n
04/16/81	2	n	n	n
04/22/81	2	n	n	n
08/12/81	27	n	n	n
09/22/82 (CH)	59	n	n	n
11/09/82 (CH)	149	n	n	n
12/01/82	100	n	n	n
12/02/82	90	1	n	n
Well 24B				
08/29/79 (CH)	14	n	n	n
08/14/80 (SH)	15	n	n	n
09/08/81 (CH)	32.9	n	n	n
09/22/82 (CH)	49.7	n	n	n
11/09/82 (CH)	116.7	n	n	n
12/01/82	100	n	n	n
12/02/82	23	n	n	n
Well 24C				
07/03/80 (SH)	3	n	n	n
09/08/81 (CH)	1.3	n	n	(25) 1.2
09/22/82 (CH)	0.9	n	0.2	n
12/02/82	n	n	n	n
Well 26				
08/07/80 (SH)	2	n	n	n
08/14/81 (CH)	1.4	n	n	n
07/20/82 (CH)	n	n	n	n
01/27/83	2	n	n	n
Well 26A				
10/25/79 (CH)	2	n	n	n
08/28/80 (SH)	2	n	n	n
08/14/81 (CH)	1.9	n	n	n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
07/20/82 (CH)	n	n	n		n
01/27/83	4	n	n	(17)	1
				(19)	3
Well 27					
09/27/79 (CH)	n	n	n		n
07/17/80 (SH)	n	n	n		n
08/28/80 (CH)	n	n	n		n
09/11/81 (CH)	4	n	n		n
09/14/82 (CH)	n	n	n	(19)	6.7
Well 29					
05/24/79 6 hrs	120	n	n	(19)	6
06/19/79 3 hrs	200	49	1	(3)	1
				(5)	2
				(19)	10
04/10/80 4 hrs	320	41	n	(3)	1
				(5)	1
				(17)	1
				(19)	10
04/10/80 6½ hrs	n	67	n	(3)	2
				(5)	2
				(19)	14
				(24)	230
04/24/80	4	3	n	(2)	1
				(6)	1
				(17)	1
				(19)	1
05/08/80 7 hrs	260	38	n	(3)	1
				(5)	1
				(19)	4
06/27/80 (NY)	3	19	30	(4)	2
12/02/80	5100	30	n		n
01/02/81	10,000	4	n	(3)	1
				(4)	1
				(6)	1
				(17)	6
				(19)	22
02/03/81	15,500	5	n	(19)	16
				unk	7 (19?)
04/21/81	8,600	n	n	(1)	1600
08/12/81	7,900	n	n		n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
01/12/82	6,200	n	n		n
03/04/82	5,600	n	n		n
02/04/83 5 min	7,000	n	n	(19)	60
				unk	20
02/04/83 1 hr	3,700	n	n		n
02/04/83 2 hrs	4,100	n	n		n
02/04/83 3 hrs	4,300	n	n		n
Well 29A					
07/16/80 (NY)	73.1	12.2	27	(22)	8.7
07/16/80	440	65	n	(5)	2
09/29/80 5 hrs	150	4	n		n
09/30/80	220	19	n		n
06/19/80 (SH)	490	51	n		n
06/26/80 (SH)	430	52	n		n
02/04/81	3	2	n	(5)	7
03/05/81	12	1	n		n
08/12/81	59	6	n		n
09/18/81 (CH)	64	6	n		n
01/21/82	330	28	n		n
04/16/82	75	7	n		n
05/18/82	110	11	n		n
08/26/82	270	25	n		n
09/15/82	250	23	n		n
09/18/82 (CH)	214	2	n		n
11/09/82 (CH)	72	25	n		n
02/04/83 5 min	4	n	n		n
02/04/83 1 hr	8	n	n		n
02/04/83 2 hrs	2	n	n		n
02/04/83 3 hrs	2	n	n		n
03/14/83	280	28	n		
Well 31					
10/04/79 (CH)	4	2	n		n
06/12/80 (CH)	2	4	n		n
10/17/80	2	2	n	(5)	1
				unk	79(2?)
06/12/80 (SH)	2	4	n		n
09/16/81 (CH)	2.7	2	n		n
03/09/82	1	2	n	(1)	1
				(5)	1
				unk	1
				unk	1
				(26)	150

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
04/05/82	1	2	n	(2)	2
				(26)	160
				unk	1
				unk	2
04/16/82	1	2	n	(26)	140
				unk	1
05/03/82	1	2	n	(1)	2
				(26)	160
05/13/82	n	2	2	unk	1
				(26)	220
01/27/83	1	2	n	(26)	88
				unk	1
				(27)	1
Well 32					
10/03/79 (CH)	40	n	n		n
11/29/79	57	1	1		n
12/12/79 (CH)	27	n	n		n
07/22/80 (SH)	31	n	n		n
09/09/80 (SH)	28	n	n		n
09/11/81 (CH)	20	n	n		n
09/28/82 (CH)	9	n	n		n
01/27/83	15	n	n		n
Well 33					
08/23/79	1	1	n		n
04/10/80 ½ hr	n	n	n		n
04/10/80 2 hrs	1	1	n		n
04/24/80	n	2	n	(6)	3
05/08/80 2 hrs	n	1	n	(6)	8
				(11)	1
07/24/80 (SH)	n	n	n		n
09/08/81 (CH)	n	n	n	(22)	4
				(28)	110
09/16/81 (CH)	2	2	n	(22)	6
				(25)	5
				(28)	124
05/10/82	1	n	n	(17)	1
				(19)	1
05/18/82	1	n	n	(17)	1
				(19)	1
Well 36					
10/17/79 (CH)	n	n	n		n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)
09/02/80 (SH)	n	n	n	n
09/18/81 (CH)	n	n	n	n
09/22/82 (CH)	n	n	n	n
Well 37				
07/17/80 (SH)	16	n	n	n
08/21/81 (CH)	13	n	n	n
02/23/83 (CH)	19	n	n	n
Well 38				
09/12/79 (CH)	7	n	n	n
07/08/80 (SH)	7	n	3	n
08/19/81 (CH)	3.7	n	n	n
09/14/82 (CH)	5.8	n	n	(25) 1.9
Well 38A				
09/12/79 (CH)	2	n	n	n
07/08/80 (SH)	3	n	n	n
08/19/81 (CH)	2.5	n	n	n
09/14/82 (CH)	3.9	1.2	1	n
Well 39				
08/23/79 (CH)	2	n	n	n
06/26/80 (SH)	3	n	n	n
08/19/81 (CH)	n	n	n	n
07/27/82 (CH)	n	n	n	n
09/14/82 (CH)	1.2	n	n	n
Well 39A				
10/11/79 (CH)	n	n	n	n
06/26/80 (SH)	n	n	n	n
08/19/81 (CH)	n	n	n	n
09/14/82 (CH)	n	n	n	n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
Well 41					
07/19/79 (CH)	26	400	n		n
11/21/79	29	480	3	(8)	1
04/10/80 1 hr	6	2	n	(6)	2
				(11)	1
				(17)	1
				(19)	1
04/24/80	180	46	n	(5)	1
				(17)	1
				(19)	9
05/08/80 ½ hr	4	1	n	(6)	5
				(11)	1
				(17)	2
				(19)	3
06/11/80 (SH)	n	n	n		n
07/03/80 (SH)	19	370	2		n
07/24/80 (SH)	21	395	2		n
09/11/80 4 hrs	26	111	n	(6)	1
				(8)	1
				(19)	1
09/12/80 4 hrs	22	285	n	(6)	1
				(8)	1
04/08/81 2½ hrs	1	n	n	(6)	1
04/21/81	n	n	n		n
08/12/81	18	230	n	(23)	1
09/02/81 (CH)	12	160	n		n
05/10/82	1	n	n		n
05/18/82	n	n	n	(17)	1
				(19)	1
08/26/82	21	210	n	(23)	2
09/15/82	18	220	n		n
10/06/82 (CH)	18.6	102.5	n		n
04/25/83 60 hrs	33	160	n	(7)	1
Well 42					
10/25/79 (CH)	n	n	n		n
08/28/80 (SH)	n	n	n		n
09/16/81 (CH)	2	n	n		n
05/20/82	n	n	n	(6)	2
09/22/82 (CH)	1	n	n	(6)	1.9
				(25)	0.6
01/27/83	5	n	n		n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)
V 42A				
09/26/79 (CH)	n	n	n	n
08/28/80 (SH)	n	n	n	n
09/16/81 (CH)	1	1	n	n
09/22/82 (CH)	n	n	n	n
01/27/83	n	n	n	n
Well 43				
09/19/79 (CH)	10	4	n	n
08/12/80 (SH)	6	n	n	n
08/26/82 (CH)	3.6	2.3	n	n
09/22/82 (CH)	13.7	3.3	n	n
10/06/82 (CH)	3.9	1.2	n	n
Well 43A				
09/19/79 (CH)	n	n	n	n
08/12/80 (SH)	n	n	n	n
08/26/81 (CH)	0.8	n	n	n
09/18/82 (CH)	4.2	n	n	n
Well 45				
10/18/79 (CH)	9	n	n	n
08/12/80 (SH)	18	n	n	n
04/08/81 (CH)	8.3	n	n	n
09/22/82 (CH)	8.7	n	n	(25) 2.5
Well 46				
08/05/80 (SH)	2	n	n	n
09/11/81 (CH)	36.3	n	n	n
09/28/82 (CH)	0.35	n	n	n
Well 47				
08/15/80 (SH)	n	n	n	n
08/14/81 (CH)	6.9	n	n	n
09/18/81 (CH)	19.8	n	n	n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)
09/25/81 (CH)	9.7	n	n	n
09/28/82 (CH)	72.8	1.76	n	n
02/04/83 (CH)	104	n	n	(5) 3
02/04/83	120	1	n	(5) 3
Well 47A				
08/12/80 (SH)	n	n	n	n
08/14/81 (CH)	n	n	n	(1) 22.6?
09/22/82 (CH)	n	n	n	n
Well 48				
07/20/79 (CH)	41	n	n	n
11/29/79	39	n	n	n
12/12/79 (CH)	45	n	n	n
07/22/80 (SH)				
	47	n	n	n
09/04/80 (SH)	39	n	n	n
11/29/80	79	n	n	n
09/18/81 (CH)	48.4	1	1	n
08/10/82 (CH)	10.6	n	n	n
Well 48A				
09/20/79 (CH)	19	n	n	n
09/04/80 (SH)	42	n	n	n
08/14/81 (CH)	54	n	n	n
08/19/81 (CH)	29	n	n	n
09/18/81 (CH)	61	n	n	n
12/02/81 (CH)	1	n	n	n
12/17/81	2	n	n	n
04/23/82	1	n	n	n
05/18/82	2	n	n	n
07/22/82	34	2	n	n
08/26/82	56	2	n	n
09/15/82	66	3	n	n
02/07/83 5 min	1	n	n	n
02/07/83 1 hr	1	n	n	n
04/15/83 25 hrs	n	n	n	n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)
Well 49				
10/31/79 (CH)	8	n	n	n
06/19/80 (SH)	39	n	n	n
08/05/80 (SH)	7	n	n	n
09/04/80 (CH)	7	n	n	n
09/18/81 (CH)	25.7	n	n	n
09/22/82 (CH)	74.1	4.1	n	n
11/09/82 (CH)	93.1	2.6	n	n
12/01/82	170	18	n	(5) 3
12/02/82	180	15	n	(5) 4
02/07/83 1 hr	52	n	n	n
02/07/83 5 min	2	1	1	
02/07/83 2 hrs	86	n	n	n
02/07/83 3 hrs	97	1	n	n
Well 49A				
07/26/79 (CH)	13	n	n	n
06/19/80 (SH)	5	n	n	n
09/17/81 (CH)	2.6	n	n	n
Well 50				
09/15/79 (CH)	2	n	n	n
06/05/80 (SH)	4	n	n	n
09/25/81 (CH)	2.3	n	n	n
08/17/82 (CH)	n	n	n	n
Well 50A				
09/09/79 (CH)	n	n	n	n
08/07/80 (SH)	n	n	n	n
08/19/81 (CH)	n	n	n	n
08/17/82 (CH)	n	n	n	n
Well 51				
08/30/79 (CH)	14	n	n	n
06/05/80 (SH)	12	n	n	n
08/21/81 (CH)	9.9	n	n	n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)
09/08/82 (CH)	38	n	n	n
10/06/82 (CH)	11.3	n	n	n
Well 52				
08/29/79 (CH)	2	n	n	n
07/01/80 (SH)	2	n	n	n
08/21/81 (CH)	1.4	n	n	n
08/17/82 (CH)	n	n	n	n
Well 53				
08/30/79 (CH)	9	n	n	n
07/01/80 (SH)	8	n	n	n
08/19/81 (CH)	6.8	n	n	n
09/08/82 (CH)	37.8	n	n	n
10/06/82 (CH)	22.4	n	n	n
Well 53A				
08/30/79 (CH)	2	n	n	n
07/01/80 (SH)	2	n	n	n
08/19/81 (CH)	2	n	n	n
09/08/82 (CH)	6.1	n	n	n
Well 54				
07/31/80 (SH)	140	n	n	n
09/16/80 (SH)	53	n	n	n
04/08/81 15 min	n	n	n	n
04/21/81	1	n	n	n
08/12/81	99	n	n	n
09/02/81 (CH)	109	n	n	n
04/21/82	1	n	n	n
04/23/82	1	n	n	n
05/18/82	3	n	n	n
08/10/82 (CH)	30	n	n	n
08/26/82	140	n	n	n
09/15/82	120	n	n	n
02/04/83	2	n	n	n
04/25/83 20 hrs	5	n	n	

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)
1 54A				
09/05/79 (CH)	n	n	n	n
07/31/80 (SH)	n	n	n	n
09/02/81 (CH)	n	n	n	n
08/10/82 (CH)	n	n	n	n
Well 55				
09/20/79 (CH)	7	n	n	n
07/08/80 (SH)	7	n	n	n
08/19/81 (CH)	9.4	n	n	n
07/14/82 (CH)	11.1	0.6	2.0	n
Well 56				
07/31/80 (SH)	n	n	n	n
09/18/81 (CH)	0.3	n	n	n
09/22/82 (CH)	n	n	n	n
W-1 58				
09/12/79 (CH)	5	n	n	n
07/17/80 (SH)	6	n	n	n
08/21/81 (CH)	4.7	n	n	n
09/22/82 (CH)	8.5	n	n	n
Well 59				
09/26/79 (CH)	n	n	n	n
08/14/80 (SH)	n	n	n	n
09/02/81 (CH)	0.25	n	n	n
09/28/82 (CH)	n	n	n	n
01/27/83	n	n	n	n
Well 60				
07/24/80 (SH)	n	n	n	n
09/25/81 (CH)	1.4	n	n	n
02/04/83	n	n	n	n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
SAU COUNTY					
Well 9					
08/25/77 (SB)	n	n	n		n
09/20/78	n	n	n		n
06/27/79	n	n	n		n
06/25/80	n	n	n		n
09/11/80 (SB)	n	n	n		n
06/19/81	1	n	n	(17)	1
				(19)	1
07/12/82	2	1	n	(6)	1
Well 15A					
09/20/78	n	n	n		n
10/17/78	n	n	n		n
03/08/79	n	n	n		n
01/18/80	n	n	n		n
01/20/81	n	n	n		n
02/01/82	n	n	n	(1)	11
				(6)	1
				(11)	1
				(17)	2
				(19)	3
02/03/83	1	n	n	(6)	1
				(11)	2
				(17)	5
				(19)	3
Well 15B					
08/24/77 (SB)	n	n	n		n
05/18/78 (NH)	n	n	n		n
09/20/78	n	n	n		n
09/25/78 7 hrs	n	n	n		n
05/30/79	n	n	n		n
07/18/80	n	n	n		n
09/11/80 (SB)	n	n	n		n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
04/20/81	n	n	n	(19)	1
05/11/81 (SB)	n	n	n		n
05/17/82	n	n	n		n
08/05/82 (SB)	n	n	n		
Well 15C					
06/14/78 (NH)	17	n	n		n
07/26/78 (NH)	11	n	n	(6)	11
06/18/79	19	n	n	(4)	1
05/21/80 1½ hrs	17	n	n		n
05/21/80 (SB)	15	n	n		n
01/20/81	10	n	n		n
02/11/81 (SB)	11	n	n		n
07/26/82	16	n	n		n
08/05/82 (SB)	10	n	n		n
Well 15D					
08/24/77 (SB)	n	n	n		n
01/04/78 (NH)	n	n	n		n
09/20/78 3 hrs	2	n	n		n
12/13/78 (NH)	n	n	n	(6)	2
06/27/79	5	1	1	(8)	3
05/21/80 1½ hrs	3	n	n	(17)	2
				(19)	7
05/21/80 (SB)	3	n	n		n
05/28/81	2	n	n	(6)	1
				(17)	1
				(19)	1
05/17/82	n	n	n		n
03/29/83	3	n	n		n
Well 16					
04/05/77 (SA)	22	n	n		n
08/21/77 (SB)	33	n	n		n
09/20/78 3½ hrs	102	n	n		n
10/13/78	63	n	n		n
10/13/78 (NY)	42	n	n		n
11/09/78	89	n	n		n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
11/09/78 (NY)	98.5	n	n		n
12/13/78 (NY)	n	n	n		n
12/20/78	170	n	n		n
12/20/78 (NY)	174.2	n	n	(6)	5.4
12/20/78 (SB)	160	n	n		n
03/16/79	142	1	n	(19)	2
03/19/79	102	n	n		n
03/28/79	310	1	n	(20)	1
04/02/79	350	1	n		
04/18/79	280	1	n		
04/25/79	380	2	n	(19)	1
05/04/79	310	2	n		n
Well 16A					
02/24/78 (SB)	n	n	n		n
05/17/78 (NH)	n	n	n	(10)	1
09/28/78	n	n	n		n
02/01/79	n	n	n		n
01/18/80	n	n	n		n
01/18/80 (SB)	n	n	n		n
05/11/81 (SB)	n	n	n		n
05/27/81	n	n	n	(17)	1
01/07/82 (SB)	n	n	n		n
02/01/82	n	n	n		n
02/03/83	n	n	n		n
Well 20					
08/25/77 (SB)	n	n	n		n
12/16/77 (SB)	n	n	n		n
04/27/78 (SB)	n	n	n		n
10/17/78 1 hr	11	9	n	(5)	6
				(10)	1
				(19)	3
03/08/79	n	n	n		n
06/23/80 ½ hr	5	4	n	(4)	5
				(19)	1
09/11/80 (SB)	n	n	n		n
01/05/81	1	n	n		n
01/15/81 (SB)	2	n	n		n
01/07/82 (SB)	2	n	n		n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
02/01/82	3	n	n	(6)	1
				(11)	2
				(17)	3
				(19)	3
02/03/83	5	n	n	(6)	1
				(11)	3
				(17)	4
				(19)	1
Well 25					
08/25/77 (SB)	n	n	n		n
12/18/78 5½ hrs	n	n	n	(8)	11
05/10/79	n	n	n	(8)	18
09/18/79 (SA)	n	n	n		n
05/27/80	n	n	n	(8)	4
09/12/80 (SB)	n	n	n		n
05/28/81	n	n	n	(5)	4
07/12/82	n	n	1		n
08/05/82 (SB)	n	n	n		n
Well 25A					
05/18/78 (NH)	n	n	n		n
05/24/78 (SB)	n	n	n		n
09/20/78	n	n	n		n
10/12/78	n	n	n		n
02/01/79	n	n	n		n
02/01/79 (SB)	n	n	n		n
01/28/80	n	n	n		n
03/28/80 (SB)	n	n	n		n
05/01/80 (SB)	n	n	n		n
01/29/81	n	n	n		n
07/21/81 (SB)	n	n	n		n
06/14/82	n	n	n		n
08/05/82 (SB)	n	n	n		n
03/29/83	n	n	n	(17)	1
				(19)	3
Well 28					
12/15/77 (SB)	n	n	n		n
01/04/78 (NH)	n	n	n		n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
08/11/78	n	71	n		n
09/11/78 (NH)	n	64	n		n
09/11/78 (SA)	--	42	--		--
09/21/78 (NY) 5 min	n	38	n		n
09/21/78 (NY) 3 hrs	n	22.1	n		n
09/22/78 (NY)	n	42.2	n		n
10/03/78 8 hrs	n	135	n		n
10/03/78 (NY) 8 hrs	n	79.2	n		n
10/13/78 20 hrs	n	117	n		n
10/13/78 (NY) 20 hrs	n	45.4	n		n
11/09/78	n	61	n		n
11/09/78 (NY)	n	n	n	(10)	590.2
12/20/78 4½ hrs	n	42	n		n
12/20/78 (SB)	n	32	n		n
12/20/78 (NY)	n	n	n	(6)	1.7
				(10)	58.9
01/11/79 5½ hrs	1	28	n		n
01/11/79 (NY) 5½ hrs	n	195.5	n	(6)	4.1
02/01/79 4 hrs	n	25	n		n
02/01/79 (SB)	n	17	n		n
03/16/79	n	17	n		n
03/19/79	n	18	n		n
03/22/79	n	19	n		n
07/09/79	n	20	n	(6)	1
				(11)	1
				(17)	2
				(19)	5
07/27/79 1½ hrs	n	21	n	(11)	1
				(17)	2
				(19)	9
08/30/79 18 hrs	n	26	n	(2)	1
09/14/79	n	34	n		n
06/25/80	1	1	n	(17)	1
				(19)	4
08/25/80	1	100	n	(17)	2
				(19)	2
09/12/80 (SB)	n	95	n		n
04/02/81	1	1	n		n
04/08/81 4 hrs	1	1	n		n
04/21/81	1	1	n		n
05/11/81 (SB)	n	n	n		n
06/19/81	n	n	n		n
08/11/81	1	2	n		n
09/09/81	3	2	n		n
02/01/82	1	1	n	(6)	1
				(11)	2
				(17)	3

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
				(19)	3
08/05/82 (SB)	n	13	n		n
03/29/83	1	14	n	(17)	2
				(19)	4
Well 28A					
05/12/77 (NY)	n	n	n		n
12/16/77 (SB)	n	n	n		n
01/05/78 (NH)	n	n	n		n
09/20/78	n	n	n		n
10/04/78	n	n	n		n
02/01/79	n	n	n		n
02/01/79 (SB)	n	n	n		n
09/14/79	n	n	n		n
05/15/80	n	n	n		n
08/01/80 (SB)	n	n	n		n
05/21/81 (SB)	n	n	n		n
05/27/81	n	n	n		n
05/17/82	n	n	n	(17)	1
				(19)	1
08/05/82 (SB)	n	n	n		n
Well 30					
03/17/78 (SB)	n	n	n		n
06/08/78 (NH)	n	n	n		n
09/20/78	n	n	n		n
09/25/78 7 hrs	n	n	n		n
05/10/79	n	n	n		n
03/28/80 (SB)	n	n	n		n
04/07/80 (SB)	n	n	n		n
04/22/80 7hrs	n	n	n		n
03/23/81	n	n	n	(17)	2
				(19)	1
05/11/81 (SB)	n	n	n		n
02/01/82	n	n	n		n
02/03/83	n	n	n	(11)	1
				(17)	1

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)		OTHERS (ug/l)
				(19)	1
Well 34					
11/08/77 (SB)	n	n	n		n
12/16/77 (SB)	n	n	n		n
04/27/78 (SB)	n	n	n		n
09/20/78	n	n	n		n
10/04/78	n	n	n		n
05/15/79	n	n	n		n
05/30/79	n	n	n	(25)	23
07/05/79	n	n	n	(25)	n
08/17/79 (SB)	n	n	n		n
01/11/80	n	n	56	(6)	1
03/05/80	n	n	2		n
03/07/80	n	n	n		n
05/21/80 (SB)	n	n	n		n
06/18/80 (SB)	n	n	n		n
01/05/81	n	n	n		n
02/11/81 (SB)	n	n	n		n
02/01/82	n	n	n		n
04/28/82 (SB)	n	n	n		n
06/14/82	2	14	n		n
02/03/83	n	n	n		n
Well 35					
08/15/77 (SB)	n	n	n		n
09/06/77 (SB)	n	4	n		n
04/13/78 (NH)	2	37	4		n
09/20/78	n	n	n		n
09/25/78 75 hrs	n	n	n		n
12/18/78 (NH)	1	7	1	(6)	1
				(11)	1
06/27/79	1	1	1		n
05/07/80 (SB)	2	4	2		n
06/23/80	n	n	n		n
03/23/81	n	1	n	(6)	1
07/21/81 (13)	7	4	2		n
06/14/82	2	14	n		n
09/15/82 (NH)	19	2	n	(6)	1
03/29/83	1	5	n	(2)	1

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
				(6)	1
Well 35A					
04/05/77 (SA)	n	31	n		n
08/24/77 (SB)	n	n	n		n
09/06/77 (SB)	n	35	n		n
03/27/78 (SB)	n	32	n		n
04/13/78 (NH)	2	36	n		n
08/11/78	1	30	3		n
12/11/78 (NH)	1	26	5	(6)	3
02/01/79	n	25	6	(6)	1
02/01/79 (SB)	2	17	4		n
01/11/80	n	23	11		n
03/28/80 (SB)	2	18	7		n
05/07/80 (SB)	n	17	5		n
01/05/81	1	23	n	(2)	1
				(6)	1
01/11/81 (SB)	2	21	7		n
02/01/82	1	33	15	(2)	3
				(5)	1
				(6)	1
09/28/82 (SB)	1	25	9		n
02/03/83	2	25	n	(5)	1
				(6)	1
Well 40					
05/12/77 (NY)	n	n	n	(23)	5
09/06/77 (SB)	15	11	n		n
01/05/78 (NH)	15	11	n		n
03/14/78 (SB)	12	8	n		n
03/27/78 (SB)	16	11	n		n
10/04/78	12	9	1	(5)	7
12/20/78 (SB)	11	6	n		n
03/08/79	n	9	1	(1)	1
				(5)	9
01/18/80	11	8	n	(5)	11
01/18/80 (SB)	11	7	2	(6)	4
				(7)	4
				(10)	2
				(11)	2
01/15/81 (SB)	10	6	n		n
01/29/81	10	6	n	(5)	11

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)		OTHERS (ug/l)
01/07/82 (SB)	10	3	n		n
02/01/82	9	6	n	(1)	1
				(5)	7
				(17)	1
				(19)	2
02/03/83	14	8	n	(6)	9
				(17)	1
				(19)	3
				(23)	1
Well 40A					
08/15/77 (SB)	14	11	n		n
09/06/77 (SB)	3	n	n		n
04/13/78 (NH)	17	12	n		n
10/13/78 (NY) ½ hr	7.7	4.2	n	(17)	1.3
				(19)	9.4
06/18/79 40 min	9	6	n	(3)	1
				(5)	5
				(6)	3
				(11)	1
				(17)	1
				(19)	6
06/09/80	2	2	n	(5)	1
				(17)	1
				(19)	3
09/12/80 (SB)	2	4	2	(6)	4
				(7)	4
				(10)	2
				(11)	2
09/15/80 (NH)	n	n	n		n
05/27/81	2	1	n	(5)	1
				(19)	1
07/21/81 (SB)	n	n	n		n
06/14/82	n	n	n		n
Well 44					
09/06/77 (SB)	12	n	n		n
01/04/78 (NH)	n	n	n		n
10/12/78 2 hrs	1	n	n	(6)	4
				(11)	1
				(17)	1
				(19)	1
06/27/79	7	n	n	(4)	1

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
				(10)	1
9/18/79 (SB)	n	n	n		n
06/23/80	1	n	n	(6)	3
08/01/80 (SB)	2	n	n	(6)	4
06/17/81	n	n	n	(6)	1
				(17)	1
04/26/82	1	n	n	(6)	1
				(16)	1
Well 44A					
11/18/77 (SB)	n	n	n		n
12/16/77 (SB)	n	n	n		n
04/27/78 (SB)	n	n	n		n
09/20/78	n	n	n		n
10/12/78	n	n	n		n
02/01/79	n	n	n		n
02/01/79 (SB)	n	n	2		n
01/11/80	n	n	1		n
05/07/80 (SB)	n	n	n		n
01/21/81 (NH)	1	1	n		n
04/27/81	1	n	n		n
02/01/82	1	n	n		n
05/28/82 (SB)	n	n	n		n
09/15/82 (NH)	1	1	n		n
Well 44B					
01/04/78 (NH)	10	n	n		n
01/26/78 (SB)	17	n	n		n
03/14/78 (SB)	15	n	n		n
03/27/78 (SB)	23	n	n		n
10/17/78 12 hrs	3	n	3		n
12/11/78 (NH)	6	n	n		n
06/27/79	69	1	1	(4)	1
				(6)	1
08/10/79 3 hrs	3	n	4	(6)	1
08/17/79 (SB)	2	4	2	(6)	4
				(7)	4
				(10)	2
				(11)	2
09/14/79	1	n	n		n
07/18/80	3	n	10	(17)	1
				(19)	2

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
08/01/80 (SB)	2	n	n		n
06/17/81	3	n	n	(6)	10
				(11)	2
				(17)	6
				(19)	7
06/18/82	2	n	n		n
Well 44C					
05/12/77 (NY)	n	n	n		n
11/18/77 (SB)	n	n	n		n
12/16/77 (SB)	n	n	n		n
04/27/78 (SB)	n	n	n		n
08/17/78	n	n	n		n
09/20/78	n	n	n		n
03/08/79	1	n	n		n
01/18/80	n	n	n		n
01/29/81	1	n	n		n
02/10/81 (SB)	n	n	n		n
05/17/82	1	n	n	(17)	1
				(19)	5
09/15/82 (NH)	2	n	n		n
Well 57					
11/18/77 (SB)	6	4	n		n
12/16/77 (SB)	6	n	n		n
03/14/78 (SB)	5	5	n		n
09/28/78 3½ hrs	n	14	1	(20)	5
12/18/78 (NH)	2	11	n		n
03/19/79	8	8	1	(4)	1
				(5)	1
				(19)	2
07/31/79	n	12	n	(2)	1
				(17)	1
				(19)	4
10/26/79 (SB)	2	11	n		n
04/17/80	4	8	n	(17)	1
				(19)	7
05/07/80 (SB)	5	8	n		n
01/20/81 (NH)	4	13	n	(24)	4
02/11/81 (SB)	6	20	n		n

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
2/01/82	9	30	n	(19)	2
2/03/83	1	23	n	(5)	1
				(17)	2
				(19)	4
Well 57A					
08/12/77 (NY)	n	n	n		n
11/18/77 (SB)	n	10	n		n
12/16/77 (SB)	9	n	n		n
03/14/78 (SB)	n	9	n		n
09/28/78	n	14	n		n
12/11/78 (NH)	n	14	n		n
03/19/79	8	8	1	(4)	1
				(5)	4
				(19)	2
11/20/79 (SB)	n	15	n		n
01/18/80	n	20	n		n
01/18/80 (SB)	n	14	n		n
01/20/81	n	11	n	(5)	1
02/01/81 (SB)	n	15	n		n
01/07/82 (SB)	n	12	n		n
4/26/82	n	21	n	(5)	1
				unk	3
01/25/83	1	22	n	(5)	1
				(17)	1
				(19)	2
				(27)	1

LEGEND

PCE Tetrachloroethylene
TCE Trichloroethylene
TCEA 1,1,1-Trichloroethane

(1) Methylene Chloride
(2) 1,1,-Dichloroethylene
(3) 1,1-Dichloroethane
(4) trans-1,2-Dichloroethylene
(5) cis-1,2-Dichloroethylene
(6) Chloroform
(7) 1,1,2-Trichloro-1,2,2-Trifluoroethane
(8) 1,2-Dichloroethane
(9) 1,1,1-Trichloroethane
(10) Carbon Tetrachloride
[illegible] Bromodichloromethane
[illegible] 1,2-Dichloropropane

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)	
?/01/82	9	30	n	(19)	2
02/03/83	1	23	n	(5)	1
				(17)	2
				(19)	4
Well 57A					
08/12/77 (NY)	n	n	n		n
11/18/77 (SB)	n	10	n		n
12/16/77 (SB)	9	n	n		n
03/14/78 (SB)	n	9	n		n
09/28/78	n	14	n		n
12/11/78 (NH)	n	14	n		n
03/19/79	8	8	1	(4)	1
				(5)	4
				(19)	2
11/20/79 (SB)	n	15	n		n
01/18/80	n	20	n		n
01/18/80 (SB)	n	14	n		n
01/20/81	n	11	n	(5)	1
02/01/81 (SB)	n	15	n		n
?1/07/82 (SB)	n	12	n		n
4/26/82	n	21	n	(5)	1
				unk	3
01/25/83	1	22	n	(5)	1
				(17)	1
				(19)	2
				(27)	1

	PCE (ug/l)	TCE (ug/l)	TCEA (ug/l)	OTHERS (ug/l)

ЗEND

PCE Tetrachloroethylene
TCE Trichloroethylene
TCEA 1,1,1-Trichloroethane

(1) Methylene Chloride
(2) 1,1,-Dichloroethylene
(3) 1,1-Dichloroethane
(4) trans-1,2-Dichloroethylene
(5) cis-1,2-Dichloroethylene
(6) Chloroform
(7) 1,1,2-Trichloro-1,2,2-Trifluoroethane
(8) 1,2-Dichloroethane
(9) 1,1,1-Trichloroethane
(10) Carbon Tetrachloride
(11) Bromodichloromethane
(12) 1,2-Dichloropropane
(13) 2,3-Dichloropropene
(14) trans-1,3-Dichloropropene
(15) Trichloroethylene
(16) 1,1,2-Trichloroethane
(17) Chlorodibromomethane
18) cis-1,3-Dichloropropene
9) Bromoform
)) 1,1,1,2-Tetrachloroethane
(21) Tetrachloroethylene
(22) Toluene
(23) Vinyl Chloride
(24) 1,1,2,2-Tetrachloroethane
(25) Benzene
(26) Trichlorofloromethane
(27) Chloromethane

Note: n = not detected at detection limits
unk = unknown substance
If no time is marked, running time is 24 hours or more, or was not specified.

LABORATORY DESIGNATION
(SH) - New York State Department of Health
(SB) - New York State Department of Health-Stony Brook
(SA) - New York State Department of Health-Albany
(CA) - New York City Health Department
(NYT) - New York Testing Laboratory
(NH) - Nassau County Health Department

no laboratory designation is indicated, laboratory is
zmacher, McLendon and Murrell, P.C.